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ON THE PRODUCTS OF THE GENUS EUCALYPTUS.

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(With a Tinted Plate.)

In these days of scientific exploration and discoveries, we are constantly needing new maps to keep ourselves posted up in a knowledge of the world. Africa seems to be the centre of attraction just now, and deservedly so, when we have the records of such expeditions as those of the Niger and Zambesi, and above all, that great solution of the Nile mystery; but Africa has always been one of the four quarters of the globe and its boundary has long been known, while the case is far different with what may now fairly be called a fifth part of the earth's surface, namely Australia; the whole island itself, extensive though it be, is comparatively a recent discovery, and the rapid progress of its civilisation, and application of its natural resources, is an instance of what may be done by English settlers. Thus we find the great fertility of Australia has been well husbanded by those who have gone forth to seek a home there.

If we take but one division of the vegetation of the tropics, namely the forest trees, and compare them with those of our own country, we shall find a most striking difference in the size of their foliage, but this is more particularly the case with Oriental plants, such as bananas, plantains, etc. The size of the trees themselves to a North American or Australian traveller is the most striking point of difference, for instance, in the former country trees of the coniferous family abound to a height of 300 or 400 feet, and in Australia the Eucalypti to an equal size. This great continent is the head quarters of the myrtaceæ, and the order is one of the most characteristic of the Australian flora, and includes some of the most gigantic trees in all the vegetable kingdom. Dr. Hooker says, in his *Tasmanian Flora*, that fully 130 species of the Eucalyptus are

known, which he geographically divides as follows :—" In S. W. Australia, 50 species; S. Eastern Australia, 60 species, and 20 tropical species." The rich dense scrub of this vast continent is almost unique in its wild grandeur. African explorers tell us of the dense and almost impenetrable gigantic grasses. In India we have thick jungle of canes and other palms, very difficult to penetrate; so indeed is the Australian scrub, but it is composed chiefly of plants nearer in general appearance, as well as by scientific classification to our own timber trees, namely dicotyledonous plants; for while in India the jungle is composed for the most part of species of calamus and bamboo, in Australia the scrub is composed of species of Eucalyptus, melaleuca, etc., intertwined with the scrub vine, a species of cassytha.

Important as the Eucalypti are in producing valuable woods, the species which furnish the distinct kinds are far from being well determined. They are generally known in the colony as gum trees, as for instance, blue gum, grey gum, spotted gum, etc., but the difficulty in identification is this, that what may be blue gum in New South Wales, may be another coloured gum in Tasmania; or a grey gum in Victoria, may be a red gum in New South Wales.

The fine collections of Australian timbers, shewn in the International Exhibition, 1862, with their admirable descriptive catalogues, went far towards clearing up many of these doubts. Of the order to which the gum trees belong we have no representative in the flora of this country. The common myrtle, a native of southern Europe is the most northern member of the family. The order is characterised by opposite, evergreen leaves, dotted with numerous small ducts or oil glands, and a vein running round the leaf, just within, and parallel to the margin; the leaves of many species of Eucalyptus are remarkably thick, the cellular tissue with the innumerable oil glands, as seen under the microscope, is beautifully arranged between the vascular fibrous bundles which are here of a very woody nature, this will be more clearly understood from the plate (Fig. 5), which is a magnified section of the leaf of *Eucalyptus tetraptera*. The dark spots show the position of the glands and are filled with a volatile oil; from the presence of these glands in leaves of such a thickness, as we might suppose, a large quantity of oil is secreted, and we remember reading that Eucalyptus leaves were used for several years in the manufacture of gas to light one of the small towns in the colony of Victoria. The quantity contained in the different leaves of the different species varies much, thus from 100lbs. of freshly gathered leaves of the Tasmania peppermint (*Eucalyptus amygdalina*), as much as three pints of essential oil

has been extracted, which, however, is the maximum yield of any one species. The specific gravity of this oil at 60° Fahr. is 8.881. It is thin, of a pale yellow colour and has a pungent odour. It burns with a bright flame, but produces much smoke, which is one draw-back to its adaptation as a lamp oil. It is non-inflammable so far as the application of a light to the pure oil goes, but when highly heated it burns freely. This oil is soluble in chloroform, turpentine, benzine, naphtha and alcohol. The tree considered as a timber tree, is less valuable than any of the other species. It is very abundant in Tasmania.

The Mallee scrub (*Eucalyptus oleosa*) yields the next largest amount of essential oil. The tree is a small one, not more than 12 feet high, and is very plentifully distributed throughout the Australian forests. The smallness of this tree, which is an exception to the general run of the Eucalypti, makes it valueless as a timber tree, but on the contrary more valuable as an oil-yielding plant, owing to the facilities offered for gathering the leaves, as well as the dense mass of foliage with which the species is covered. The odour of the oil somewhat resembles that of rosemary, it is thin and of a rather pale brownish colour, it burns well in a lamp with a clear white light, producing little or no smoke, and emitting no smell. The specific gravity is 0·911.

The Blue gum of Tasmania (*Eucalyptus globulus*, Lab.), is one of the largest, as well as the most valuable of all the Australian gum trees, it is an enormous tree, growing some 350 feet high, and having a circumference of 50 to 100 feet. The trunks of these monsters of the Australian forest frequently grow to a height of 200 feet before any branches are given off; the wood is exceedingly hard and heavy, so dense indeed that it is almost an impossibility to cut it with the ordinary carpenter's tools of this country, it well repel a nail of almost any degree of hardness, it is well adapted for underground work, or in damp situations, and has been recommended for ship building. Respecting the geographical distribution of this species, Gunn says, "that though abundant in S.E. Australia and even in Flinders Island, is nowhere found in Tasmania, except to the southward of 60 miles S. of Launceston." The tree is conspicuous, not alone for its great size, but also for its large leaves and flowers; when crushed, the leaves emit a most powerful odour, which of course arises from the fracture of the glands, and the setting free of the volatile principle of the oil. In the young leaves of this species, the oil cells are very large and numerous, and the oil itself is the most valuable of any for illuminating purposes.

The Stringy bark of Tasmania, (*Eucalyptus gigantea*, Hook,

fil,) has a wide distribution through S. Eastern Australia, being very abundant in, and indeed forming the bulk of some of the forests of the elevated table land of the southern mountains. Like the last named species it is a very large tree, producing a wood little inferior in hardness; it is said, however, to shrink or swell according to atmospheric changes. Its bark, which peels off in flakes, is of a very fibrous nature, hence the vernacular name of the tree; it was for many years used by the natives for covering their huts, building their canoes, etc., they still apply it to many useful purposes.

The barks of the different genera of the myrtaceæ are, perhaps, the most varied of those of any other known family. Even in the genus Eucalyptus itself we find in some species barks of two or three inches in thickness, and very solid; while in others, as in *E. gigantea*, we find them so fibrous, as to split up naturally into strips or thongs. In the thick barked species, called in the colony "iron barks," the wood is immensely hard, as is also the outer bark, which is very rugged and uneven. The substance of the bark partakes of the colour of the wood, that is of a reddish brown, and a dark resin is thickly dispersed through it in small irregular pieces, having a very bright fracture. A similar substance may also be seen in some species crowded between the annular rings of the wood, showing that the whole of the secretions of the plants must be highly charged with this principle. This resin can in many species be obtained in large quantities, and it is known to some extent in this country as Australian kino. The barks of some species of melaleuca are entirely composed of numerous thin layers or plates of a paper-like substance, which can be peeled off to almost any size, and it has very much the appearance of a sheet of tinted tissue paper.

The flowers of the Eucalypti are peculiar in the form of their calyx, the sepals being united in a cup-like lid, called an operculum; this lid covers the stamens, before expansion, and afterwards falls off in one piece. It is from this that the name of the genus is derived, *eu* meaning well, and *kalypto* to cover.

A flower of *E. tetraptera*, from which the cap or lid has been removed, is shown at Fig. 1. The numerous stamens are also here shown. The size of the flowers and fruits vary much in the different species. The Fig. is drawn to nearly natural size.

Besides the several products of the Eucalypti just enumerated, one or more species yield a manna, one kind of which "is ordinarily found in the form of irregular little rounded masses, of an opaque white colour, and having a pleasant, sweetish taste. In the early months of summer it is most abundant, being secreted by the leaves and slender twigs of

Eucalyptus viminalis, from punctures or injuries done to these parts of the tree. The little masses often present an aperture at one end, showing the attachment of the small twig, from which the manna has been secreted in a liquid form, at first transparent and of the consistence of thin honey, and then becoming solid, drops off in the condition that has been mentioned. It consists principally of a kind of grape sugar, and about five per cent. of the substance called mannite."

"Another variety of manna is the secretion of the pupa of an insect of the Psylla family, and obtains the name of Lerp among the aborigines of the northern districts of the colony. At certain seasons of the year it is very abundant on the leaves of *E. dumosa*, and these are occasionally whitened over with a profusion of this material, so that the shrubby vegetation has the appearance of being iced. It is found in masses of aggregated cones, each covered with a filamentous material like wool, and has a colour varying from an opaque white to a dull yellow. Beneath the little dome or shield, which presents on the concave side a somewhat reticulated character, the pupa remains until ready for its further development, when it escapes by forcing its passage through the apex of the cone. The woolly material alluded to is composed of solid filaments, more or less striated transversely, and, in some instances, distinctly corrugated or beaded. They give a faint series of colours by polarized light, and when submitted to the action of iodine, immediately become intensely blue.

"These varieties of manna are of no medicinal value, and apart from their consideration as objects of natural interest and curiosity, have obtained but little notice."

From what we have now said it will be seen that the economic value of the genus Eucalyptus is very great, and might be made much more so by showing the uses of the products not only in the colony of Australia, but also in this country. The large yield of essential oils by the different species might be turned to some account. If not obtainable in quantities sufficient for exportation to England for illuminating purposes, they might be found very useful were they better known amongst our perfumers, for it cannot be denied that some of them have a very agreeable odour, though, perhaps, rather heavy; but this is an obstacle easily got over by those whose business it is to please our smell, and who, in these days, prepare most agreeable perfumes from most outlandish bases. A small collection of these oils was exhibited in the International Exhibition, 1862, most of which are now in the museum at Kew. They were shown with a view to their adoption for dissolving resin in the manufacture of varnish. The stated price at that time at which they could be supplied

was six shillings per gallon. In a report of some experiments made by Mr. Rimmel the perfumer in scenting soaps with these oils, he says, "Three ounces of the oil were sufficient to scent very strongly eight pounds of soap, at a cost of about one farthing per pound." We have, therefore, every reason to think that soapmakers would find great advantage in using these new essential oils. We can only say that we should be glad to see these, as well as other vegetable oils of Australia, become articles of commerce in this country. As regards the timber of the genus their durability is a recommendation, but their extreme hardness would go against their application for building or similar purposes with us. The colonists of Australia, however, use not only the species we have here mentioned, but all that produce timber of any applicable size.

The hardness of the woods of the Eucalypti is due of course to the greater density of the vascular and cellular tissues, which is the chief formation of all dicotyledonous stems, but if we examine cross sections of the wood of the blue gum (*Eucalyptus globulus*), teak (*Tectona grandis*), or oak (*Quercus pedunculata*), we shall find that the concentric circles are more clearly defined in the oak than in either of the others. The vascular tissue forming part of these annular rings is shown in numerous little pits or holes, and are much more numerous in the Eucalyptus. These fibres partially traversing each other longitudinally, of course give strength to the wood, and the more thickly the fibres are disposed, so much stronger must the wood be. The growth of the cambium layers, which, in their earliest stages, are viscous semifluid formations between the outer wood and the inner bark, and in their action adding to both, and forming the alburnum, or new wood of the stem, presses inwardly upon the woody layers already formed, and causes the heart wood or duramen to become more solid, as well as of a darker colour. Though all dicotyledonous stems are formed in the same way, in this of the blue gum, where the vascular fibres are in greater abundance than they are even in the oak or teak, and where the trees grow to such an enormous size, and attain to such a great age, the strength and hardness of the wood naturally follows; besides this, the whole trunk appears impregnated with a resinous matter. Then, again, the medullary rays are so close together, as scarcely to be seen by the naked eye; magnified, however, as in Fig. 4, they exhibit themselves in a series of fine lines. No wood is so well calculated to show these rays, which carpenters call "silver grain," as the oak; in a transverse section of this wood they are generally very visible in one unbroken line from the very centre to the circumference of the trunk. This is shown in Fig. 3.

By comparison of the three sections shown on the plate we

arrive at the following conclusions:—That in Fig. 2 (teak) the concentric circles are not so wide as they are in the oak, Fig. 3; the teak, therefore, derives greater strength in this respect, but the medullary rays being wider apart, and not so thick in themselves as they are in the oak, some strength must here be lost by the teak and gained by the oak. Now if we compare the magnified section of blue gum, Fig. 4, with either teak or oak, we shall see at a glance the greater density of the vascular fibrous bundles, as well as the innumerable medullary rays and the closeness of the annular rings. We can thus account for the great strength, weight, and durability of these woods. We have chosen oak and teak for comparison with the Eucalyptus, being two well-known hard woods.

THE PLANET SATURN.—VARIABLE STELLAR LIGHT.—OCCULTATIONS.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

Few persons, we imagine, can ever have viewed Saturn for the first time through a powerful telescope without a feeling of astonishment. And a more intimate acquaintance with it will only increase that feeling. Such, indeed, is the case, more or less, with all the works of the great Creator. So far from losing anything by the minutest examination, their wonder grows upon the inquiring gaze. Even objects of little external promise, or deviating from the generally received type of beauty, when closely scrutinized, invariably disclose features that plainly bespeak their Divine Author, and mysteries that baffle all man's investigation. But in the case before us, the most graceful elegance of design is united with a singularity of arrangement which at once awakens a curiosity, never to be satisfied in our present state of existence. If we exclude the annular nebulæ, whose true structure is so little understood, and which from other points of view might perhaps present a very different aspect, we have no other instance of a *ring* throughout the visible universe; H^{l}'s suspicion of such an appendage to the planet which he discovered having been discarded by himself, and the conjectured ring of Neptune being equally unconfirmed. And not only does the perforation seem to be unique, but the flatness also. Whether the apparent completeness of level might be borne out on a closer approach may admit of a question; but as compared with the spherical or spheroidal form obtaining everywhere else, it possesses an absolutely ex-

ceptional character. And, combined with all this, if complexity of structure, and extent of superficial area, and profusion of attendant retinue, may be considered indications of intrinsic superiority, then Saturn is the most important of all the planets, which owe allegiance to our sun. And though in earlier days its distance from the source of light and heat, and the imagined ultra-Siberian character of its climate, may have been supposed to imply some inferiority to those who, like ourselves, occupy a less remote position, yet a closer examination of this style of argument would show it to be inconclusive. The same mode of reasoning would advance Mercury to a precedence as regards ourselves which we have no reason to admit; quantities of light are merely comparative, and its diminished amount would be readily balanced by that increase of sensibility to its action, which even on the earth is acquired by the inmates of mines and dungeons; and the recent discoveries by Professor Tyndall with regard to the absorption of radiant heat by aqueous vapour, have shown the possibility, without being obliged to resort to any extravagant assumption, of the preservation of a similar temperature throughout very extended limits of distance from the sun. Such considerations are, however, after all, immaterial. He whose wisdom is equal to his goodness, has doubtless so fitted up that magnificent globe that its inhabitants—and whatever may be held to the contrary, such we believe to exist—are as fully provided as ourselves with everything necessary, not only for their existence, but for their happiness. And if, with faculties and powers of observation at all resembling our own, they look down upon our globe as a poor, insignificant, ringless, and well-nigh unattended habitation, fit only for beings of a very inferior class, if indeed inhabited at all, while demurring to their conclusion, we could scarcely find fault with the premisses from which they derived it.

Every lover of astronomy in our latitudes must regret the present depressed position of Saturn, while the rings are gradually spreading out to their fullest extent, and about eighteen long years have yet to pass before their broadest development will return in a favourable position as regards our northern skies. The student, however, must be exhorted to watch carefully for those opportunities of clear and steady vision, which recur from time to time even at low elevations. And perhaps the following attempt at a detailed description of the principal features of the planet, even if it should be of less service as a guide in our present unfavourable circumstances, may not be without its use as a preparative for future seasons. In reviewing the whole system, we shall commence with the globe, and subsequently proceed to the rings and satellites.

THE GLOBE OR BALL.

1. *Dimensions.*—This is a magnificent spheroid, inferior only, and that in no great degree, to Jupiter, among the attendants of the sun. The earliest attempt with adequate instrumental power to ascertain its magnitude was that of H_5 in 1789. His result, however, which when reduced to the planet's mean distance, gave 20″·196 for the equatorial diameter, is now known to be too large. Bessel gives several reasons for ascribing it to the irradiation of the reflector, which he thinks must have been greater than that of his own achromatic, but admits a difficulty (a serious if not fatal one) attached to that supposition in accounting for the definition, in such a telescope, of the minute divisions of the ring. The micrometer was more probably in fault. Schröter's subsequent measure 19″·64, though better, was still but an approximation. Σ (*i. e.*, Wilhelm Struve, or Struve I.) next attacked the object with the Dorpat achromatic, the first large instrument of that class, and the last completed by Frauenhofer, having an object-glass of 9·6 inches, and great optical perfection; with this he made it 17″·991. Bessel, between 1830 and 1833, employing the so-called heliometer, or more properly divided object-glass, at Königsberg,* found it, from seventy observations, only 17″·053. The principal measures of more modern times are, Jacob, 17″·94; Galle, 17″·906; Secchi, 17″·661; De la Rue, 17″·66; Struve II., 17″·6; Main, 17″·5. These measures are not, indeed exactly accordant, but if we allow them all equal weight, omitting H_5's and Schr.'s as deviating too widely, the mean, 17″·664, will differ from the greatest value only by 0″·327, a quantity too small to affect sensibly our ideas of the planet's magnitude.† This, from the last obtained value of the solar parallax (8″·9159) would give, in round numbers, 74,700 miles for the equatorial diameter, absolutely dwarfing, in comparison, the 7926 miles beneath our own feet.

2. *Ellipticity* or *Polar Flattening.*—This characteristic of many planetary globes is developed most largely of all in Saturn, and will be very apparent, especially when the thinness of the ring prevents its interference, even with small apertures and moderate magnifying powers. The axis of the

* This was the first of these instruments that had been constructed of sufficient size to meet the advancing demands of astronomy. Its aperture was 6·2 inches, and its focal length, 8·5 feet, and so complicated were its adjustments, that for its transport from the workshop of Merz, at Munich, to its destination, no less than twenty-seven packing-cases were employed.

† The above determination is less accurate than it may appear, from the inevitable allowance of equal weight to all the values. I have subsequently been most obligingly favoured by Mr. Dawes with his own hitherto unpublished results, the mean of a large and very accordant set of observations, 17″·421. The difference between this, and the amount in the text, is, for all practical purposes, immaterial.

planet being very much inclined (63° 10′ 32″·13), the compression will of course be greatly masked, excepting when the earth is in the plane of the Saturnian equator, and the poles are projected on the limb; at other times we should measure, not the value of the polar axis, but that of a line joining two points where the compression does not attain its full amount. Hence the apparent will always exceed the true ellipticity, excepting about the time of the disappearance of the ring, the plane of which is identical with that of the equator. The published measures of several of our best observers are, therefore, not available, having been taken at other epochs, and not hitherto reduced to their polar value: the following, however, are the results of direct or reduced measurement :—H, $\frac{1}{10\cdot364}$; Bond, $\frac{1}{11\cdot6}$; Lassell, $\frac{1}{11\cdot05}$; Hussey, $\frac{1}{10\cdot9}$; De la Rue, $\frac{1}{13\cdot18256}$; Main (Greenwich), $\frac{1}{9\cdot22}$; Bessel, $\frac{1}{9\cdot06}$.* The discrepancy is greater than might have been expected, and shows that a larger number of measures are still required to obtain a satisfactory mean. Dawes has pointed out one source of difficulty, especially with the heliometer, and double-image micrometer, in the feebler light of the polar regions; and thinks such great amounts of compression irreconcileable with the planet's appearance, remarking that "the eye may sometimes be trusted more than the micrometer."

3. *Abnormal form* of the ball. This, though now considered illusory, attracted so much notice in its day, that it should not be omitted here, especially as there is no improbability in its occasional recurrence. In April, 1805, when the ring, which had been invisible less than two years before, had not as yet widely opened, H was struck with the singular appearance of the planet, exhibiting an equatorial as well as polar flattening; these regions appearing, comparatively, almost rectilinear, and the points of greatest curvature, or those through which the longest diameters would pass, being fixed, after repeated and fairly agreeing measures of position, in lat. 43° 20′. Of the reality of this appearance the illustrious observer seems to have entertained no doubt; and few would be bold enough to question the competency of his testimony. There seem to be only four ways of accounting for it. It must either have arisen from a temporary change of form; or from a distorted telescopic image; or from atmospheric influence; or from optical illusion. The first solution, if not a physical impossibility, is too improbable to be admitted, excepting on the most compulsory evidence: the second is negatived by the

* Bessel's own determination was $\frac{1}{10\cdot46}$. But this, singularly enough, was a mean obtained from measures many of which were unreduced to their normal value; and Main found, when polar measures alone were retained, that they gave the amount specified in the text.

great care taken by the observer to employ a variety of instruments, of 7, 10, 20, and even 40 feet, as well as to observe simultaneously the form of Jupiter, which showed no distortion: the third would have been too uncertain and transitory: it only remains for us to infer that when outlines of dissimilar degrees of curvature, inclination, and brightness approach or intersect each other, the judgment of the eye is liable to be misled. And we have no reason to suppose that this was a peculiarity of this great astronomer. Schröter probably referred to it when he stated that with his 13-ft. reflector he saw Saturn 1803, Aug. 5, not everywhere spheroidal: and Kitchener tells us that he perceived the form described by H with two achromatics, for a few months only, after occasional observations during nearly thirty years, in the autumn of 1818, when the ring must have been very narrow, as its edge was turned towards us in March of the following year. The Astronomer Royal, too, had on one occasion a similar impression; though at another time the reverse, that of a flattening in lat. 45°, and cites the instance of a person unacquainted with H's observation, who made spontaneously the same remark as to a flattened equator.

Something of a similar nature, too, has been very recently repeated. In Jan., 1855, when the ring was near its widest expansion, Coolidge, one of the observers with the great American achromatic of 14·95-in. aperture, imagined on some nights that the greatest diameter of the globe was inclined about 20°, though on the 9th the equatorial seemed the greatest; and on Dec. 6th he says, "I cannot persuade myself that it is an optical illusion that makes the maximum diameter of the ball intersect the limb at half way between the N. edge of the equatorial belt and the inner ellipse of the bright ring B." In the *Report of the Greenwich Observatory for* 1860-61, it is also stated that "Saturn has sometimes appeared to exhibit the square-shouldered figure." Other somewhat analogous phenomena have been noted at the American observatory. 1848, July 11. Bond II. says, "the ball of the planet seems to be most flattened at the N. pole:" and his father, Aug. 29, "the ball does not appear to be symmetrical, but is flattest at the N. pole." This was during the disappearance of the ring. On the other hand, four times during 1855 and 1857, when it was very widely opened, it is recorded that the apex, or greatest projection of the antarctic region upon the outermost ring lay to the apparent left of the position of the pole, as shown by the form of the belts: once, the reverse way: and once, exactly coincident. The outline of this region also occasionally appeared irregularly flattened and distorted, from its juxtaposition with the black unconformable shadow

upon the ring: and a similar illusion was noticed by the late G. P. Bond (or Bond II.) on two nights in 1857, when the close approach of the shadow of the ball to the extreme edge of the ring caused the outline of the latter to be conspicuously deflected as though to meet it.* Independently of deceptions of this nature, the liability of even an accurate and practised eye to be influenced by the mere oblique position of an elliptical outline was evident in the case of Schröter, who thought he perceived partial flattenings of the disc of Jupiter, subsequently proved to be illusory by the heliometric measures of Bessel.† In conclusion, we have to remark that however unpleasant it may be to have to admit such a degree of fallibility in our vision, the measures of Bessel during the disappearance of the ring in 1832, and those of Main at a similar epoch in 1848, have been considered conclusive as to the unreal character of this "square-shouldered" form, and that it has been pronounced by the Astronomer Royal irreconcileable with the theory of gravity.

4. *Belts.* These, though not very conspicuous features, are sufficiently visible, even with very small telescopes; an aperture of two inches being sufficient to indicate their existence. Their analogy with those of Jupiter is evident at the first glance; and their almost undeviating direction parallel to the equator, as well as their frequent and very extensive changes, sufficiently indicate their vaporous origin. Upon the probable assumption that the dark streaks are the real surface of the planet, their diversified colour would indicate a less uniform arrangement of materials on the body of Saturn than on that of his larger neighbour; though it must be borne in mind that the considerable inclination of Saturn's axis brings his polar regions distinctly into view, while those of Jupiter always remain withdrawn into an extreme foreshortening. At any rate, the contrast of hue between the equatorial and the polar districts of Saturn suggests a difference of character to which no terrestrial analogy offers us any clue; but this is not matter of surprise, when we consider the wide dissimilarity in the conditions of existence. With a bulk somewhat about 750 times that of the earth; with a density, on the contrary, only three-quarters that of water—so that it would float like a cork on a sufficiently extensive ocean; with an amount of light equal to little more than one-hundredth of our own, it is

* Something of the kind was seen in 1843 by De-Vico at Rome with the 6¼-in. achrom. in the ring, which he describes as having, at times, irregular or partially misshapen ansæ. But these observations are not equal to the American in point of accuracy.

† An interesting illustration of a somewhat similar illusion is given in our last No., p. 223, under the title of "Deceptive Figures."

evident that no speculation as to its materials and structure can lead to even a plausible conclusion. The fact, however, is certain, whatever it may mean, that there is a decided difference of tint between the zones of lower and higher latitudes, the latter being of a bluish or greenish grey, the former being occupied by one or more broad bands of a faint brown or ruddy cast.

This varied colouring has been especially recorded by Lassell, Secchi, Dawes, and Bond II.,* and was beautifully brought out 1855, Dec. 7, in the magnificent 10-ft. Newtonian, the workmanship of Mr. De la Rue, when I was kindly favoured by that gentleman with such a sight of the planet as forms one of the memorable events of life. The pole itself is sometimes marked by a lighter tinge, but often is dusky, and occasionally exhibits an extremely sombre hue, indicating probably the clearness of its sky, and at no time does it seem that any defined or contrasted snowy brightness, such as brings out the poles of Mars, has been noticed there. On the contrary, the most luminous part of the globe, if not of the whole system, is a broad white or yellowish girdle encompassing the equator, which has been erroneously referred to reflection from the ring, but is, in all likelihood, as in Jupiter, a dense tract of vapour. The strong inclination of the axis of Saturn to its orbit, which is given at 63° 10′ 32″·13, very little differing from our own, 66° 32′ 36″, must, from analogy, be supposed to indicate a very decided change of seasons, which, it might fairly be supposed, would be attended with a periodical variation in the disposition of the belts; but beyond a remark of H, who thought that the polar regions were whiter after they had emerged from wintry darkness, no observations seem to have been especially directed to this interesting inquiry. Were the white belt simply due to the action of the sun, it may be thought that it would change its position, or at least, its extent, with the varying position of the sun in the Saturnian sky; it seems, however, not unlikely that its situation may be additionally influenced by the vicinity of the ring; but it must be admitted that our experience of an atmosphere, whose cloud-bearing portion, at any rate, is able to keep pace with the surface beneath it, ill qualifies us for speculating on the conditions of one, in which, from the extreme velocity of rotation, a perpetual E. wind seems universally to prevail. It is true that modifications in the direction of the belts, sometimes

* Coolidge, an excellent observer, with the same great telescope, while frequently referring to the "brick-red" tint, ignores the bluish-grey, an instance of "chromatic personal equation." The ball had an extraordinary dark and leaden colour as compared with the ring, according to the Roman observers 1842, July 3, which had disappeared by the 5th. But they seem not to have been aware of the long recognized inferiority of light of ring A till some time after this observation!

amounting to 15°, were noticed by ♄, and that De Vico in 1843 remarked an occasional want of parallelism with the ring; still these exceptions, though possibly attended with decided consequences in the planet's climate, do not affect the general rule. But, at any rate, either from gradual and imperceptible transfer by oblique currents, or, what is perhaps more likely, from alternate precipitation and solution, or from both, these belts are subject to many changes. Their aspect is at times surprisingly regular. ♄'s "quintuple belt" of 1793, sufficiently remarkable in this respect, has been surpassed in later times. Under date of 1857, Jan. 30, Bond II. tells us that "S. of the broad dark, equatorial belt, is a regular and very striking succession of light and dark zones; indeed their regularity is so great that had I seen them in an engraving, I should have thought it too precise to be either natural or true." In all, there were six white zones, including the pole, and five belts, in one hemisphere. At other times, this extraordinary regularity is less conspicuous. Dawes, 1854, Sept. 26, found that the broad dark belt S. of the equator was not of uniform breadth; and were our remoteness less extreme, we should probably often witness what W. C. Bond (Bond I.) relates on one occasion (1848, Aug. 29), that "the belts appear by glimpses to be diversified like those of Jupiter;" and again (Oct. 28) that the edge of the equatorial band was uneven; and a somewhat similar irregularity, 1849, Nov. 12, 13:—or the subdivision and dispersion noted by Lassell, 1852, Nov. 4, when the number of minute belts and stripes all over the ball defied his delineating powers.

5. *Spots*, or other markings. These are much less frequent than upon Jupiter, as well as less easy of observation from distance and deficiency of light; but on this account they well deserve remark. A very early instance, and a very decided one, considering the probable character of the optical means employed, is recorded in 1683, when Cassini and Fatio are said to have seen a bright streak, which disappeared the next day, another then becoming visible near the limb.—1780, June 19. ♄ observed a dark cloudy appearance not far from the centre of the disc; and two days subsequently a "strong dark spot," probably the same, was seen near the limb, which 36m. afterwards was "not so remarkable," though (supposing his figure to be inverted) further on the disc, and therefore perhaps of as evanescent a character as those of Jupiter.—1796, 1797. Schr. and his assistant Harding noticed dusky moveable spots.—1806, June 9. ♄ remarked that the brightness of the N. polar regions was "here and there tinged with large dusky-looking spaces of a cloudy, atmospheric appearance."—1847, Nov. 8. Schwabe perceived, with a 6-ft. achromatic, a

dark cloudy spot, similar to the spots of Jupiter, on the S. edge of the dusky belt N. of the equator, extending somewhat into the bright equatorial zone [as those of Jupiter have been frequently observed to do], and having a perceptibly rapid motion.—1848, Aug. 29. Bond I. says, "Towards the S. pole an outline as of a continent is discernible;" and during this autumn, with the same telescope, there are notices on three other nights, of a faint diversified appearance of the S. hemisphere, which seems to have offered a contrast to the "hooded" style of the N. in this respect. The sun, it may be remarked, was at this time passing from the N. to the S. side of the planet, and the former had been receiving the greater share of his influence for half the Saturnian year. And with this we may connect an observation of Bond II., who remarked, 1849, Nov. 16, the bluish-white hue of the N. pole as compared with the more golden tinge of the S.—1848, Sept. 9 and 10. Busch and Luther, at Königsberg, saw a bright round spot near the S. limb (singularly enough, the planet was observed on Sept. 8 and 11 in America, but not on the nights in question). The earth was in the plane of the equator on 13, so that it could not have been a white polar cap.—1852. Jacob, at Madras, found mottlings, and slight cloudy patches, especially towards the pole. Nov. 4. Lassell detected a number of minute and exquisite markings, in addition to three bluish-green belts, on the S. portion of the ball.—1856, March 27. Coolidge noticed a narrow "penumbra" E. of the polar cap. Dec. 1. Bond II. found a dark irregular streak on the limb close to the S. pole.—1858, Jan. 11d. 10h. 30m., and 14d. 11h. 20m. Dawes observed a well-marked light spot a little past the axial line at 40° or 45° S. lat. April 17. Lassell noticed a pretty-well defined bright area of some magnitude. To the above may be added the mention by the American observers, on two occasions, of a mottled texture in the dusky equatorial belt, and the darker markings of the same part shown in one of the beautiful views of De la Rue, 1856, March 27.

6. *Reflective Atmosphere.* To the abundant indications which these facts afford, of the existence of a gaseous envelope of varying density and temperature, H would have added another, that of refractive power, finding that the satellites, when passing behind the globe, hung on the limb a long time before they vanished, the retardation actually amounting to 20m. in the instance of Mimas (the innermost), and 14m. or 15m. in that of Enceladus. But this observation has not been confirmed; nor, indeed, does the case carry with it much *primâ facie* probability, as so great a depth of refracting medium would necessarily distort the outline of the ring when it makes an acute angle with, and behind, that of the ball, an effect to which

allusion has never yet been made. The presence, however, of an atmosphere of considerable density, though not of a depth perceptible at the distance of the earth, is suggested in another more probable way, by means of reflection. The American astronomers have on many occasions recorded the deeper colour of one or more of the dusky bands in their central portion, and the occasional impossibility of tracing them, or some of them, as far as the limbs; these appearances, the latter of which at least is well known to the observers of Jupiter, evidently point to the existence of an imperfectly transparent atmosphere. In one instance Bond II. records having seen the planet brighter at the edges than the centre; and of this Chacornac obtained a more direct proof with the largest telescope in the Paris observatory, from the aspect of Titan (the principal satellite) during its transit across the ball, 1862, May 1; this phenomenon, the reverse of that presented by the disc of Jupiter, is referred by that observer to the difference of the two atmospheres in reflective power.

7. *Rotation.* — Several of the previous evidences of an atmosphere are equally proofs of axial movement, and that of a rapid character, change of place having been perceptible in the spots during very brief periods of observation. From the infrequent occurrence, however, and transitory nature of any defined markings, few astronomers have attempted to deduce a diurnal period, and fewer still have done so with any approach to success. Huygens inferred it, as in Jupiter, but only from the motions of the satellites. Whence Bugge got his strange results of 5h. 59·4m. and 6h. 4·3m. does not appear. Calandrelli's 11h. 39m. from the ellipticity, is precarious. Schröter and Harding's three values in 1796 and 1797, 11h. 51m., rather more than 12h., and 11h. 40m. 30s. are thought inferior to those of ♅, who, from observations in 1793 of the aspect of different portions of his "quintuple belt," composed of three dark and two bright bands, which varied somewhat in definition and distance, deduced several closely-agreeing periods, the most satisfactory of which was 10h. 16m. 0.44s. On one occasion, Dec.'12, he was enabled to trace the rotation through an arc of 329°, and he thought it improbable that his result could be in error 2m. either way.* Dawes's spot in 1858 would, however, give a period of about 8m. longer. The received result admits, it may be concluded, of improvement, but it will probably not be modified to any very important extent.

The Ring-System.

This marvellous appendage, when fairly opened out in the

* H. has given 10h. 29m. 17s., but it does not appear upon what authority.

course of the planet's annual revolution, is too conspicuous to escape notice even with telescopes of very inferior dimensions. I have myself seen the ansæ with a common little hand-glass, aperture only 1½-inch, and power about 20, so that it is not surprising that Galileo, with his power of 33, should have perceived what, as an unknown object, conveyed the impression of a triple globe. It is, in fact, more to be wondered at that none of the observers before Huygens caught at its real nature, since their figures, uncouth and queer as they are, are some of them sufficiently suggestive of the truth. Our remarks upon its structure and peculiarities as a whole, will find a more convenient place after we have given some account of it in detail. We shall begin with the outer zone, which in accordance with the suggestion of Struve II. is now usually designated as ring A.

I. Ring A.

1. *Dimensions.* This, the most surprising annulus of all, if we take into account the combination of external circumference with thinness, was measured at its outside by H, 46″·677; so much in excess that the micrometer must have been in fault. Σ made it 40″·095; Jacob, 39″·997; De la Rue, 39″·83; Main, 39″·72; Kaiser, 39″·515; Bessel, 39″·4; Bond, 39″·35.* The mean of these modern values is 39″·7, equalling in round numbers 168,000 miles, whence results a circumference of 528,000 miles; an amazing circle, which an express train, at a continuous speed of 60 miles per hour, would not quite compass in a year. How difficult it is to realize this, in gazing at that ellipse which looks so small in our telescopic field! From a mean of Jacob's measure of the interior diameter, 35″·82; De la Rue's, 35″·33; and Σ's, 35″·289, we get the corresponding amount about 150,000 miles, and the breadth (half the difference) 9,000 miles.

2. *Reflective power.* Though by no means a feeble object, its inferiority in brightness to its neighbour is very evident, and has been remarked almost ever since the discovery of its separate existence. We find it noticed by Cassini in 1676, who compared, with little appositeness, the relative luminosity of the two rings, A and B, to that of polished and unpolished silver. I have even seen it with only 2¼-inches of aperture, and it appears to be a permanent characteristic. The American observers ascribe to it a bluish tinge, and have noted differences in its aspect which will be subsequently particularised.

* Additional measures by other observers, or the same at other epochs, might be given; but the above are quite sufficient for the purpose of showing the nature and the limits of micrometrical work. The remaining uncertainty renders it better to give the miles in round numbers only.

3. *Subdivisions or Markings.* It was stated by Lalande, that Short, a most celebrated maker of reflecting telescopes, who died in 1768, had seen, about the middle of the last century, with a 12-foot reflector,* this outer ring subdivided by several lines. This observation was never confirmed by H, who seems to have thought the alleged fact improbable. However, Gruithuisen says that on two nights in 1814 he saw a division on this ring with a Frauenhofer of less than 3½-inches; and in December 1823, Quetelet, of Brussels, in trying an achromatic by Cauchoix of 10⅔-inches at Paris, perceived a similar appearance. Two years afterwards Capt. Kater, in examining Saturn with a power of 280 on a very beautiful Newtonian reflector, by Watson, of 6¼-inches aperture and 40-inches focus, saw it "separated by numerous dark divisions, extremely close, one stronger than the rest dividing the ring about equally." Another very good reflector, by Dollond, 6¾-inches aperture, failed to show this then, but it gave a similar though less distinct image on two subsequent nights. When so clearly seen (1825, Dec. 17), the ring "appeared to be divided into two parts, nearly equal, by a strong black line, and each part to be subdivided into at least two others by fainter black lines." A friend compared these markings to "coarse line engraving," without specifying any predominant division among the six which he drew; another, with the focus unfortunately not adjusted, saw only the one stronger line. From the invisibility of these markings at other times Kater inferred their variable nature. This may be deemed the more probable since Σ with a (nominal) power of 540 on the great Dorpat achromatic could perceive no division in 1826; and a still more striking testimony to the same effect was borne by H. who says, "I was fortunate enough, on the 4th of April last (1830), to procure a view of Saturn in the 20-ft. reflector, such as I never again expect to obtain. Nothing could exceed the perfection of definition of the body, ring, belts, and satellites, with a power of 320, and the whole aperture of 18¾-inches open. * * * Not the least trace of a subdivision of the ring into more than two could be seen, though I looked for it with all possible attention, and with all powers and apertures." Yet even after this, the missing objects were to turn up again.—1837, April 25. Encke, at Berlin, with a telescope, the fellow of that at Dorpat, perceived a minute dark streak on each ansa (or broad end) of A. May 28th. He measured its distance 1″·485 from the outer,

* This admirable workman made several Gregorian reflectors (the fashionable construction of the day) of this size; one for Lord Spencer, in 1743, which cost 600 guineas; another in 1752 for the King of Spain, for which, with the whole apparatus, he received £1200. This was the noblest instrument of its day. It would be matter of curiosity to ascertain its present condition.

0″·715 from the inner edge of the ring, (as reduced to mean distance from the earth). And from him this division has been commonly designated.—1838. May to August (and again 1839, 1840, 1842, 1843), De-Vico and others with the 6½-inch Cauchoix at Rome saw it repeatedly and distinctly. June 15 and 25. Galle at Berlin glimpsed it, especially on the *p* ansa. —1839, June 10. He caught it again.—1841. Schwabe saw it out of thirty observations with a 6-ft. achromatic on four occasions, July 26, Aug. 10, 17. On E. ansa alone; Sept. 10. On W.—1843, Sept. 7. Dawes and Lassell, with the 9-inch reflector of the latter, both saw it in a hazy sky (frequently very favourable to definition, by the testimony of many of our best observers). It was visible on both ansæ, rather outside the middle of the ring, and seemed ⅓ of the breadth of the principal division to D; scarcely so much to L.—1845, Sept. Hind had a distinct view of it with Mr. Bishop's 7½-inch achromatic. —1851. It was twice suspected by Schmidt. Sept. 2. Secchi found some traces of it with 63 inches. Sept. 9, 10. In the finest weather, Lassell, with 22 inches of reflecting surface, received the impression that the ring was striped or marked, but not divided. Sept. 15. With an image of great beauty, and powers 170 to 1100, it was not visible to Hartnup in the Liverpool achromatic of 8½-inches: Dawes, however, on several nights this autumn saw it on both ansæ with his 6½-inch object-glass as a very narrow black line, when best seen "far too dark, narrow, and sharply defined to be merely a shading or a belt:" it was considerably nearer the middle of A than a dark line seen last year, and very nearly placed as, but much narrower than, Encke's division of 1837 and 1838 as figured by himself. Nov. 12. Fletcher and Pattinson with a 7½-in. object-glass both saw it at intervals, nearest outer edge.—1852. Lassell, with the 24-inch speculum, and in the Maltese sky, found no division on A, though usually a lighter band at the inner edge, ⅓ of its breadth: sometimes the light would shade off uniformly outwards, at others it would brighten up again, though in a less degree, at the exterior edge of the ring. Sept. 25. Dawes, with admirable distinctness, though through considerable fog, saw a very narrow dark line, a little exterior to the middle: the outer being less luminous than the inner portion, and the brightest part being close to the innermost edge. Last year and this, he sees this narrow dark line; which Bond, Σ, and Lassell have failed to detect with their much larger instruments; and he makes the following important remark: "Is it not possible that in telescopic, as well as in microscopic, observations, a certain quantity of light may be the most favourable for the discerning of extremely narrow dark lines on a luminous ground? Certainly, in my own telescope, such delicate phænomena are not most plainly

seen when the planet is most brilliant, but rather, as on the exquisite night of Oct. 26, 1851, when the heavenly bodies are shorn of much of their usual splendour." This observation suggests the enquiry, whether under some circumstances a pale screen-glass might not have a good effect in such delicate researches. Jacob, at Madras, with 6·25 inches aperture, sees a division round more than half the circumference, its breadth being $\frac{1}{7}$ or $\frac{1}{8}$ of that of the great division, say 0″·1, and its position, by the micrometer, 0″·91 from the outer, 1″·345 from the inner edge. This, therefore, if such minute measurements can be trusted, was not in the position of Encke's division.—1852, Nov. De la Rue executed a magnificent representation of Saturn, in which there is a division immediately exterior to a very narrow bright band, occupying the centre of A. Nov. 29. Bond II. thought A appeared as if its light and shade were a repetition of those on B. Dec. 1. The same, with a seam on A, and its *p* edge touched with whiter light.—1853. Hind saw a division rather outside the middle, plainest on E. side. Oct. 24. Dawes traced it a long way round, just outside the middle, precisely as last year. Dec. 15. Bond II. perceived it as a division, shading, or seam; A was brightest at its inner edge.—1854, Feb. 13. After several suspicions, Breen and another observer saw it, obvious and distinct, in the great Northumberland telescope at Cambridge, with which Challis had perceived it twice before (1842 and 1845).—1854-5. Dawes, with his A. Clark of 7½-in., found the inner edge of A brightest; and towards the middle a very dark narrow well-defined pencil-line, which, Nov. 26, was traced more than half-round, and well seen with powers up to 1000. Its appearance and position were the same as during the three previous apparitions of Saturn.—1854. Secchi, with the Merz achromatic at Rome, of 9·6 inches, found Saturn with a power of more than 1000, as if turned in ivory; but there was no division upon A; only a dark tracing like a pencil-line all round, always visible at about $\frac{1}{3}$, reckoning outwards, of its breadth. Dec. 26. Coolidge, with Bond's great achromatic, found with certainty one division in the outer half of A, and possibly a second outside of it. Dec. 27. Two, and he suspected three divisions; his figure represents one marking outside the centre, and a fainter one on each side of it, the space between the inner and the principal one occupying the middle of the ring.—1855. Jan. 9. The same. Jan. 25. He traced one dusky seam "in the middle" of A nearly all round, and for one moment thought the outer half again subdivided. Feb. 28. One dusky division on the ansæ only. Mar. 29. The seam easily seen. Nov. 13. A brighter than usual. Nov. 26. Though darker than B, brighter than ever seen before. Nov. 30. Seam visible. Dec. 6. Vision exceedingly good; powers 401, 688, 1243; faint dusky

seam, at times traced three-quarters round: possibly a second one. "I do not see the ring A as well as the rest of the planet. Even when the definition was at its best, this ring and its outer edge were undecided, its inner ellipse remaining all the time steady, clear, and very sharp. Indeed the inner ellipse in its S. half is better defined than the outer edge of the ring B." Dec. 16. Secchi, during "*une vue ravissante*," noticed an additional very narrow line nearer the inner edge, not one-third as broad as the other, and no doubt scarcely $\frac{1}{6}''$ in width. Dec. 23. Ditto. 24. The same, very distinct: atmosphere magnificent. Principal streak 1″·596, second, 0″·5 at utmost, from inner border; seen all round except above planet, where they were a little confused: the pole was then in contact with the inner edge of A. This ring shaded off darker and darker from the inside, and was faint at the outer edge.—1856. Mar. 18. Coolidge found the seam plainly visible. Mar. 20. A not as well defined as the ball, or B. Mar. 27. "A is better seen than it has been of late. The seam also is more distinct and narrower, and has a sharper contour than it usually presents. It can be seen through two-thirds of the circumference." April 1. Finest definition hitherto: powers up to 1561: one single division on A, thought to be visible all round.

1855-6. Watson (Durham) with a very fine Newtonian, 12-in. aperture, found the marking broader and less black than the great division reduced to a *minimum visibile* by contracted apertures; and hence inferred that A was not divided, but merely marked by a dark streak, which he also thought of variable intensity. This same season it was seen three times by Dawes.—1856. De la Rue published another noble engraving of his views on Mar. 27 and 29, in which the representation is as before, excepting that the division and its attendant bright stripe are both nearer to the outside of A, the whole breadth of which is streaky. Sept. 5 and 7. This "fine division" was well seen at Teneriffe, with a $7\frac{1}{4}$-inch object-glass, by Professor Piazzi Smyth, during his most interesting and successful "astronomer's experiment," to ascertain how much definition might be improved by leaving beneath us the denser strata of the atmosphere. Nov. 8. Hartnup and another saw a dark line, placed as in De la Rue's latter engraving. The definition was but of average goodness, and Hartnup had frequently seen the planet better, and with higher powers, without being able to detect it.—1857. Jan. 20. Morton found the line defined with great sharpness in Lord Wrottesley's $7\frac{3}{4}$-inch achromatic, and glimpsed it Jan. 29. Jan. and Feb. Jacob, at Madras, had no difficulty in always seeing it in good air, even with a power of 170, but thought it not a division, but a pale streak, one-third or rather more of the breadth of the great division. Jan. 30. Coolidge observed a division, nearer perhaps to the in than

outside; on the inside shading off rapidly, leaving a bright inner edge; on the out, fading more gradually without any definite boundary, so as to make the exterior the darker half. Feb. 11. Seam on *f* side, not noticed on *p*. Feb. 12. Division exactly like Secchi's "pencil-line," its own breadth outside the middle, and one-fifth the breadth of A, traced round two-thirds of ring. Inside perhaps brighter. Feb. 14. Very faint seam about two-thirds from inner edge, which latter has a white band contiguous to it, very plainly seen, and traceable three-fourths round. Feb. 23. Bright rim wider. Mar. 4. Definition, now and then, exceedingly fine; power 688. "This ring is more uniform in colour than usual. There does not appear to be any division in it, but merely a slight decrease of light from the sides towards the interior. It struck me also as being rather brighter than it generally is." Mar. 16. Definition quite good: pencil-line quite a difficult object, and only seen near major axis; it has no definite outline. From near the outer edge the shade increased up to a point slightly within the centre, thence decreasing much more rapidly, so as to leave the inner half much the brighter. Mar. 26. Power 401; pencil-line not easy; rather nearer inner edge; less difficult, as well as narrower and darker on *f* side; with 141 invisible: "this ring struck me under this power as being very bright."—1858. April 17. Lassell, during a most favourable view with 20 inches and 650, concluded that "nothing in the slightest degree approaching the nature of a division could be detected;" nothing more than a very slight shade.—1860. Mar. 10. Jacob with Fletcher's 9¼-inch object-glass saw well a faint line on A. —1865. Mr. With, of Hereford, and another, with a 9¼-inch silvered glass speculum, saw distinctly and independently a dusky streak, most evident on *f* ansa.*

If to the above I may add my own very unimportant experience, it may be stated that I have repeatedly in former years had, with 3·7-in. aperture, an impression of the streakiness of A, but only from knowledge of the observations of others, except perhaps 1852, Sept. 23, when, definition being remarkably beautiful, Mrs. Webb, a friend, and myself, had a distinct view of its stripy or striated aspect, as though there were one or more subdivisions too minute to be plainly recognized. Its light was much fainter than that of B, and of a different colour. With my present 5·5-inch aperture, 1859, Feb. 23, I saw evidently some kind of marking upon this ring.

To many readers, this prolix and monotonous recital of minute details may seem to require an apology. Such, it is hoped, may be found in the circumstance that this is the first attempt, so far as the compiler is aware, to collect into one

* Strange to say, the late Gen. Mitchel was never able to see any division upon A with the Cincinnati Merz achrom. of 12 (Paris?) inches aperture.

narrative the whole (or nearly the whole) of the accessible evidence relating to this point; especially including the valuable American observations comparatively very little known in this country. The matter has been the subject of some discussion; and though it unquestionably wears the aspect of a trifle, and at first sight may seem not worthy of the pains, yet not unfrequently trifles hold the keys of greater mysteries. In the present instance, something perhaps may be deduced from the comparison of details which the previous recital of them enables us to take in hand. It is evident that there is a considerable discrepancy, which, as in a former case, can only be resolved into either—1. Differences of instrumental power. 2. Differences of sight, or *personal equation*. 3. Atmospheric disturbance. 4. Real instability in the object. A careful scrutiny seems to show that none of the former causes are adequate to the effect. Reflectors are not, as was at one time supposed, all ranged on one side, and refractors on the other; neither are the results of apertures and powers consistent: observers are not uniform in their own remarks; weather, however great may be its effect, has sometimes operated in the inverse of expectation; and however less probable, in comparison, the last inference might *à priori* have appeared, yet we seem to have no other resource. The writer offers, however, this suggestion with much deference, and would not be surprised if others, better capable of judging, were to arrive at a different conclusion. But if it should be admitted that these markings are in their own nature variable, the study of these minutiæ has led us to a result of some interest:—this ring must either be enveloped in a very changeable as well as dense atmosphere, or it can hardly be composed of solid materials. We are not prepared to infer anything further at present; but "*est quadam prodire tenus*," and our trouble has not been quite thrown away.

With our notice of this ring, we may suitably include some account of the Principal Division of the Ring-system, or as it may well be called, Ball's Division, since it was discovered by Dr. and Mr. Wm. Ball, 1665, Oct 13, at Minehead, with an old refractor of nearly thirty-eight feet.* It is, indeed, a very conspicuous object when the ring is well opened, and I have thus seen it very distinctly, with a power of only 80 on a 3·7-inch aperture. Mr. Grover, of Chesham, a very painstaking observer, who is cultivating astronomy with small instrumental means, but great diligence and accuracy, informs me that he has seen it with a similar power, and only 2 inches of aperture.

* Wallis wrote to Huygens in the same year, to inquire whether he could see nothing to suggest the idea of a double ring, but on what ground I am unable to ascertain.

I have many times wondered at its ready visibility, considering the very small breadth accorded to it by the concurrence of many eminent observers. Thus, with 250, and I believe with lower powers, on 3·7 inches, I have traced it easily across the ball, where it subtended only half the width of its projection in the ansæ, which is given by Σ 0″·408; Secchi, 0″·5 to 0″·402; Jacob, by estimation, nearly 0″·6; Bond, 0″·35. It certainly seems strange that a black line, thus shown to be only ½ of a second broad, should be so distinctly seen in moderate telescopes, especially when we consider that the bright space on either hand would encroach upon it from the known effect of irradiation, which in larger and more perfect instruments is of less amount.* However, it is probably due to the comparative feebleness of the planet's light. The telescope which showed me this minute line would not separate double stars 6 mag. at 1″ distance, but the apparent discs of such stars, from their vivid radiance, attain very perceptible dimensions, while a line or edge of planetary light will not be similarly enlarged, from its feebler intensity; resembling in this respect the apparent discs of very minute stars.

It seems certain that this great division is a real opening between the rings. Cassini, who did not perceive it till 1675, though the discovery has been frequently claimed for him—and even by the usually most accurate Humboldt—seems to have had an idea of its real nature, stating that it was divided "quasi in duos annulos concentricos;" and Herschel considered himself entitled to decide positively, in 1792, from continuous observation of its position and aspect on both sides of the ring, that it was not a mere marking, but an actual separation. That it is not simply a black streak as if painted on the ring seems on every account probable, but whether it is an absolute vacancy, or whether it may be occupied by some thin and nearly transparent material, the same possibly with that of the new dusky ring C, may be questioned. The following recital of observations may possess some interest in this respect, as well as in regard to certain variations which have from time to time been perceived in its sharpness and breadth, and which ought to be taken into account in the study of the system.

As far back as 1792 and 1793, Schröter, employing Newtonians of 4, 7, 12, and 13-feet focus, observed variations in the visibility of the division in the opposite ansæ. Sept. 2, Dec. 26 and 31. It was best seen by far on the E. side. Jan. 18 and Feb. 26. It was equally distinct on both. Mar. 4. The W. end was the broader. Mar. 7. It was plainest on the E. side. Mar. 12, on the W. Professor Schrader, the best re-

* From a comparison of measures taken by night, with others a little before or after sunset, Σ concluded that the irradiation of Saturn in the Dorpat telescope amounted to only $\frac{1}{11}$″.

flector-maker probably of his day in Germany, assisted at some or all of these observations. Schröter remarks, very justly, that reflectors of 20 and 40 feet would show such little variations less plainly, as a diminished breadth on one side in a smaller instrument renders that part invisible.—1821, Oct. 21, to Dec. 11. On almost every clear evening, Kunowsky and others, with a 6-feet achrom., saw Ball's division invariably fainter in the W. than E. ansa, nor was it widest at the greater axis, but a little S. in E., and a little N. in W. ansa; as if the rings were not in the same plane.—1838, June 15. Galle, with the Berlin 9·6-inch achrom., thought the inner edge of A as ill-defined as that of B.—1841. Schwabe found the division sometimes more distinct in one, sometimes in the other ansa; sometimes alike in both: on W. side, in several instances, broader, fainter, and less defined than on E., and as though bordered by a minute line on either hand.—1843. De-Vico, with the 6·3-inch achrom., at Rome, saw the division sometimes broader on the one, sometimes on the other side.—1851, Jan. 23. Schmidt thought it probably better defined W. than E. Dawes saw it black and sharp this year: De la Rue, Aug. 13. "Black as if drawn with ink."—1852. Jacob, at Madras, found it "decidedly not black, but little if at all darker" than C, where that ring crosses the ball; its inner edge being pretty sharp, but the outer rather shaded off; this also appears in a fine drawing by him (inferior only to De la Rue's), in which, it has no definite boundary: and such, he states in 1856, was its appearance to his eye. Lassell, with the 2-feet mirror, in the air of Malta, observed its paleness where the globe might be and probably was seen through it, and this is shown in De la Rue's figure of this year.—1853, Jan. 8. Bond II. remarked the same.—1854, Nov. 19. Secchi, with a power of upwards of 1000,* saw it as if drawn with ink. Dec. 9. Coolidge found N. half broader and better defined than S. (or further) half.—1855, Jan. 9. Much less distinct, and narrower near S. limb of the ball (which interrupts it) than on opposite side. Jan. 25. Upper (further) half better defined than ever before. N. half narrower than usual. Feb. 17. Secchi and another agreed that it seemed broader in the upper (S.) than the lower part of the ring. Feb. 28. Coolidge, upper half much better defined than lower, which is not visible close to N. pole [from transparency?]. Mar. 5. N. half undecided. S. half, especially *sp.* quadrant, distinctly seen. Mar. 18. Secchi, not black, only a little darker than ring C. Nov. 26. Coolidge, rather better defined in S. than N. half. Nov. 28. *sp.* quadrant better seen than the rest. Dec. 6. S. half broader and more decided than N. half: quite faint immediately over the

* Qu. nominal? Encke's scrutiny at Berlin reduced by a large amount the supposed powers furnished by the same maker.

N. pole [visible through it?]. Its edges do not seem regular, especially *f*, near axis major, "they have the appearance of being made up of a number of unequal straight lines." Dec. 24. Secchi's *nunquam melius;* perfect definition with 1000. Division not black, but reddish, like ring C. Dec. 27. Not black.—1856, Jan. 7. Lassell saw division much less black than shadow of ball, or sky within C, "which are both pre-eminently and intensely black;" being "a brown or greyish black." Jan. 16. Secchi, bluish, as C now appears. Mar. 14. Coolidge, edges not parallel at major axis, *f*. Mar. 20. Very good definition: uncertain whether division visible across N. pole. A not as well defined as B, or the ball. Mar. 27. Contour perfectly elliptical, division considerably darker in broadest part of *sp*. and *nf*. quadrants than elsewhere: visible, though very faint, across N. pole, April 2. Secchi, division broader behind than in front of planet; apparently from rings not being in the same plane. Apr. 11. Scarcely visible on nearest side, while plain and wide enough on the other, so that A seems tilted up towards the observer.—1856-7. Jacob, with an almost incredible minuteness of observation, traced the shadow of the globe across the division, "which, therefore, cannot be a mere opening, but must be filled with matter of some kind."—1856. P. Smyth, at Teneriffe, saw it not black, but of the tint of C. This year De la Rue announced that he had for the last five or six years noticed irregularities in the relative widths of the division at the major and minor axis.—1857, Jan. 30. Coolidge observed S. half the broader; N. reduced to a hair near minor axis, but equally dark. Feb. 12. Broader, blacker, and better defined *sf.*: outlines not perfectly elliptical: near major axis, especially *f*, edge of B irregular, making division appear distorted: the whole division rather darker than common. Feb. 14. Seemingly not formed of perfect ellipses, but contour not pointedly deficient as on 12: rather faint, though not narrow, across ball. March 4. Examined specially; not thoroughly elliptical; somewhat irregular within 20° of E. and W. points. S. half better defined, and perhaps slightly broader than N. March 16. Ellipticities of the two edges different; irregularities near major axis seeming to vary every night. March 26. Regular (except *nf.?*); S. half better defined than N., but *np*. and *nf*. quadrants near major axis darker than *sp*. and *sf*.—1858, Apr. 17. Lassell, brown, as contrasted with black shadow of ball on ring.

We must now suspend for the present our description of this wonderful system.

VARIABLE STELLAR LIGHT.

Mr. Huggins and Dr. Miller are prosecuting a *most interesting* examination of the spectra of Variable Stars, by which they hope to obtain "new information of the probable mode in

which, in some stars at least, the periodic alteration of light of these remarkable objects is brought about." At present they have only made public their results with respect to *a Orionis*, in which they have found that "a group of lines and shading as if of fine lines" has disappeared of late during the maximum brilliancy of the star, which, according to Mr. Baxendell, is variable in colour as well as light.

OCCULTATIONS.

May 19th, 60 Cancri, 6 mag. 11h. 39m. to 12h. 18m.—22nd, 76 Leonis, 6 mag. 7h. 39m. to 8h. 43m.

DESCRIPTION OF THE LUNAR ECLIPSE OF 31ST MARCH, 1866,

As seen at Arbroath, Lat. 56° 34′ *N. Long.* 2° 35′ *W.*

BY ALEXANDER BROWN.

SINCE the evening of Friday the 13th October, 1837, there has been no such favourable opportunity for witnessing the varied phenomena of a total eclipse of the moon at Arbroath, as on the morning of Saturday the 31st March, 1866. For hours previous to the entrance of the moon into the earth's dark shadow, not a cloud covered the face of the sky; and Luna was beheld pouring her mild radiance on field and town, path and moor. At thirty-eight minutes past two in the morning, Greenwich mean time, she began to be obscured, the *umbra* of the earth slowly reaching from spot to spot. After this the glare of that part of the moon's disc, still enlightened by the direct rays of the sun, rendered the eye insensible to the more feeble illumination produced upon the eclipsed part of the disc by the refracted solar rays. As the eclipse proceeded, and the magnitude of the part of the disc directly enlightened decreased, the eye, partly relieved from the excessive glare, began to perceive very faintly the moon's eclipsed limb, which was visible from the beginning by a telescope, in which it appeared of a dark grey hue. When the entire disc, at forty-four minutes past three, had passed into the shadow the eclipsed moon became distinctly visible, showing a gradation of tints from blue to green on the outside, to a gradually increasing red, which further on changed to a colour resembling that of incandescent iron when at a dull-red heat. As the lunar disc approached the centre of the shadow this red hue spread all over it, although not so brilliant as would otherwise have been the case in consequence of the appearance of the grey dawn of morning and the increasing twilight preceding

the rising sun. The total phase ended at twenty-two minutes past five. The moon set two minutes after sunrise and thirty-seven minutes before the termination of the eclipse. In the eclipse of 13th October, 1837, Sir John Herschel observed various and changeable distributions of light on the eclipsed disc of the moon, arising from a partially clouded state of the earth's atmosphere, patches of red light corresponding to the clear portions of the atmosphere being thrown into the *umbra*. During the total eclipse of 19th March, 1848, the moon was remarkably bright while passing through the earth's dark shadow, so much so that some persons doubted her being eclipsed. At Arbroath, the evening of the 19th March, 1848, was rainy, and the moon did not shine out during any portion of the time she was eclipsed. The next total eclipse of the moon, visible in this country, will be near midnight on the 12th of July, 1870.

NOTES ON A WINTER VISIT TO MOUNT ETNA.

THE ERUPTION OF 1865.

BY PROFESSOR D. T. ANSTED, F.R.S.

Few people out of Sicily are aware of the magnitude of this eruption, and although the site was visited during the past year by many travellers from various countries, the real geological interest and the points of special importance noticed by local observers have not yet been placed before the scientific world. No English geologist seems to have visited Etna during the time of its chief activity, from January to June, but the phenomena were carefully studied, and until the close of the summer season the state of affairs was continually watched, by very competent and intelligent chemists. Since August the site of the eruption has not been visited until on the 1st February, a few days after the anniversary of the eruption, I accompanied Professor Orazio Silvestri, of Catania, to the spot. This gentleman is preparing a memoir on the chemical phenomena, and is well capable of describing and illustrating all that was to be seen of the eruption by an eye-witness during the most important and earliest moments.

The nearest town from which the site can be visited is Giarre, about twenty-four miles south of Catania, on the road to Messina. It is a place of some size and business. The accommodation for strangers is thoroughly Sicilian, and not at all promising at first sight, but many worse places exist, some of which look better outside, and the traveller will find fair beds and decent food, with excellent wine. Starting from here in the early morning (about half-past four A.M.), and mounted

on excellent donkeys, my friend Professor Silvestri and I made the best of our way over roads and paths as bad as can be conceived, and up a steady ascent commencing immediately, and averaging about one in sixteen. We passed two or three villages, the last of which was St. Alfio, and reached in due time the upper part of the wooded region of Etna. We arrived at snow at a height of 3380 feet above the sea. From this point we had to walk over very thick snow, often reaching nearly to the tops of the trees, till at the height of 5130 feet above the sea, we reached one of the earliest of the lava currents of last year. The first view of the cones, craters, and lava-currents of the late eruption, all of the most intense black colour, and standing out from the snow in such a manner as to show with the utmost precision the exact spot on which the eruption had taken place, was inexpressibly striking. This contrast was, of course, the result of the melting of the snow over those places where the lava and ashes were still warm. The whole surface, but especially the principal cones and the numerous lines of fissure, were still covered with fumaroles, and continued to emit much aqueous vapour. This was mixed here and there with muriatic acid, quite sensible to the lungs, though hardly in a state to be collected without difficulty in sufficient quantity for analysis. More generally the vapours were slightly alkaline.

The phenomena of the eruption of 1865 were first noticed on the 28th of January, by the inhabitants of the village of St. Alfio, one of the highest inhabited points on the eastern slopes of Etna. Though the ground above the village was thickly covered with snow, a great fissure, nearly fourteen miles long and of great width, commencing at an elevation of 6360 feet, was seen to open from the foot of the great crater on its north-eastern side, crossing the Monte Frumento, an extinct cone of large size and considerable height, and extending far down into the terrace below. This crack crossed nearly at right angles the direction of the Val del Bove, the ancient crater of Etna. So large is it that it has ever since remained a prominent feature in the scenery, and I observed it with perfect ease by the unassisted eye from the magnificent ruins of the old Greek theatre at Taormina, a distance of more than fifteen miles in a direct line. Although of such grand dimensions, it opened with little noise or convulsion, but notwithstanding this, and the absence of ordinary marks of the commencement of a great eruption, it seems to have split the old cone of Monte Frumento almost in half. Out of part of the yawning cavity there boiled up and ran over almost immediately and along a line about half a mile in length, a lava-current in a state of great fluidity, pouring out at first at the rate of more than

thirty feet per minute, and continuing afterwards at a slower rate. Several days after the first eruption, it still advanced at the rate of five yards per minute. The lava issued from a point a little below, and at the foot of Monte Frumento, and its outburst was accompanied with constant tremblings of the ground, felt to a considerable distance, and by the usual incessant rain of hot ashes and burning fragments of scoria, but not by any important earthquake. In the course of two days the ashes had already formed three principal cones of eruption, from all of which the showers continued to erupt, accompanied by loud detonations. The larger red-hot blocks of stone and scoria were thrown up and carried by the wind to a distance of half a mile, and the ashes more than fifteen miles. These three and subsequently four other cones of eruption were all on an irregular line having the general direction of the fissure, and were all within a distance of about a quarter of a mile. The first issue of the lava ran towards the south-east, but the great mass poured from the opposite side, and soon took a definite course downwards, leaving a small island covered with pine-trees and birch, surrounded by the sea of liquid fire. This island still remains. The shower of ashes, accompanied by many very large volcanic bombs or lumps of scoriaceous lava, was sufficient to render any near approach impossible, except from the windward side. The trees near the point of eruption in the direction of the wind were stripped of their branches, some of them being left as bare as a flag-staff, the branches being cut off short to the trunk. Others were burnt. Several of the bared and injured trees remained unaltered at the time of my visit.

The lava continued to pour forth pretty steadily, one layer running over another as it descended the steep face of the mountain, through the wooded region into the cultivated lands below. It advanced, in all, upwards of seven miles, doing much mischief to property and vegetation, but little to animal life. Its extremity was sometimes as much as forty feet in height, and it filled up as usual all irregularities of the surface, presenting at the time of my visit a vast blackened pile of loose ashes and lumps of scoria, covering compact lava of the usual kind. The eruption continued very active for some weeks, but then diminished in intensity, though still proceeding till the month of August. Fortunately for the inhabitants of the villages below, the lava-current stopped at a very early period. Even the eruption of ashes on a grand scale had greatly diminished within fifteen days of the first outburst, and after that time the aqueous vapour, constantly pouring forth in large quantity, was mixed with a much smaller proportion of gases than at first. Some time after the eruption was over, there was

a serious earthquake in the immediate neighbourhood which was extremely fatal to human life, and this was the only destructive part of the event.

Although this eruption was unusually sudden, and took place without any of the usual warnings, there had been marked indications of uneasiness in the great crater of Etna for some time previous. The latest of these of any magnitude had taken place in June, 1863, or nearly twenty months before. Still there had been general evidence of the existence of unusual pressure under and near the great crater, although nothing indicated the precise direction of the disturbing force which so suddenly and effectually exerted itself as already described.

Among the phenomena which especially attracted notice during this eruption may be mentioned a peculiar crackling noise heard during the advance of the lava, and the mode in which the already cooled surface was re-melted and welded to the advancing mass. Each wave seems to be always overlapping the last, cementing it to itself, and projecting a little beyond. The lava erupted seems, however, to have been always in incomplete fusion, consisting of crystals floating in fused glass. The temperature, however, as tried by metals thrown into it, was exceedingly high. After becoming quite pasty, it would still almost fuse copper, and Professor Sylvestri found that in this state it readily melted silver, and had reason to believe that when thoroughly fused its temperature was above that of melting platinum.

At the time of my visit the snow covered a large proportion of the upper part of the first lava-current near the principal cone at the foot of the Monte Frumento, but many patches were bare. Wherever blocks of lava projected, there came forth much vapour, too hot to permit the hand to be held in it, but for the most part the irregular surface of the current had been subsequently covered with a thick coat of fine black ash, over which the snow lay in considerable thickness. Circular holes in the snow, sometimes eight or ten feet deep, marked the position of the principal fumaroles, which always had reference to some projecting solid block.

The cones are still tolerably perfect. There are six, and one of them having a double crater, there are seven craters. The principal cone in point of height, at the time of my visit, was one of those nearest Monte Frumento, and there was another of large size, the furthest from that cone. The rest are smaller. They do not appear to have changed much since the summer. All were on the part of the main fissure from which the lava was erupted. The highest part of the largest cone was 340 feet above the lava at its foot. It was a heap of fine

and coarse ashes with occasional large blocks of very cellular lava. All the material at the surface was perfectly loose, standing at a slope of 33° and very difficult to climb, as it slipped perpetually from under the feet. It was nowhere altogether cold, and in parts there were many small fumaroles of aqueous vapour. The walls of the cone were by no means of the same height all round, one side being removed almost to the level of the bottom of the crater, which was about one hundred feet below the principal summit. The sides lowered gradually from the highest point to this level, which was near the later eruptions of lava. The action of the weather may have affected the form of this cone, and helped to wear it down and smooth its irregularities; but this action is smaller than might be expected, as all rain and snow is absorbed as rapidly as it falls.

At the top of this cone, and extending nearly in a straight line to the craters of the next and much lower cone, in the direction of Monte Frumento, were seen many coloured and black strips, all smoking, and presenting an appearance highly characteristic. The colour is varied from white to the most brilliant orange. These lines marked the position of narrow clefts, through which extremely hot vapour issued. The vapour arose chiefly from small holes under and close to erupted blocks of lava and scoria that formed part of the crater. It was chiefly aqueous, but sufficiently charged with chlorine to be disagreeable to the lungs, though not actually dangerous. The temperature varied. In some places it did not exceed 80° Fahr., and in others it approached 200°, but this refers only to the depth of a few inches below the surface reached by the bulb of a thermometer. The vapours were generally acid, and these were very much the hottest. The holes through which the vapours issue are the *fumaroles*. They are the means by which communication is made from the heated interior with the external air. By their means the water absorbed or present below the surface is re-evaporated, and the gases that are still forcing themselves upwards, or are produced in the heated rock by chemical reactions, are discharged safely. A few of these fissures are not apparent, except from the fumaroles themselves; others are clearly marked by lines of colour, and some few are wide and visible cracks of the surface, also intensely coloured.

The appearance of the interior of the two principal craters was very grand, and both of about the same character, though the craters were some distance apart. In both the main eruption was over, and the gullet or hole through which the principal outburst of ashes had taken place was closed, and filled with cold scoriæ. In both also the sides in certain parts were

intensely hot, and great chemical change was going on. The principal crater is the most perfect and regular. It is entered from one side by a natural opening, and close to this part the floor is extremely hot, far too hot, indeed, to be touched by the hand. But the gullet, which is a cylindrical depression like a large shallow well in the centre of the bottom of the crater, about 200 feet in diameter and 20 feet deep, was closed and cold. There were three points of action in this crater, all easily recognized from some distance by the strong mirage produced by the heated air over them. Besides that on the floor of the crater close to the entrance, there were two on opposite sides, one near the bottom and the other high up. The other crater was smaller, but very much deeper and much less accessible. Its lowest point was about 150 feet below the bottom of the higher crater, and it is situated about 300 yards further from Monte Frumento. The top of this cone is only ten feet higher than the bottom of the principal crater, not including the depression formed by the gullet.

By far the most striking and characteristic feature of both these principal craters, and of the whole of the active part of the volcano generally, was the extraordinary brilliancy of the colours, almost entirely yellow, passing on one side into white, and on the other through orange into red, which defined the position of the crevices, and the places from which there was the chief issue of vapour. The great clouds of steam rising incessantly from the walls of the craters, sometimes obscured these colours; but whenever the wind drifted away the steam, they reappeared with the most startling vividness. Standing in the crater near the bottom, one could look down upon a large surface of these bright tints. On the walls of the crater, and near the top, the same thing was repeated on a large scale. Fragments of the coloured rock had fallen from time to time, and partly covered the floor, but they were much less vivid. The imagination instantly suggests that this bright yellow colour is the result of those sulphur emanations of which so much is said in the accounts of volcanic eruptions, and certainly the idea is very natural; but it is quite incorrect. Scarcely any native sulphur was to be found in these craters at the time of my visit, and none at all existed in an efflorescent state on the walls of the crater.

The history of the brilliant colours on the walls of a crater of eruption is both curious and instructive. It is, as usual in all matters concerning the structure of the earth, a history of change and metamorphosis. The vapour that issues from the interior as steam, under high pressure, and with sufficient force to eject lava or melted rock in all varieties of form and texture, brings with it various gases. At the begin-

ning and in all the early stages of the eruption, chlorine is one of the most important of these. Hydrogen, nitrogen, and oxygen are always present. Towards the close, carbonic acid gas becomes abundant. After the main crevice or fissure through which the chief eruption has come is finally closed, these gases, in various combinations, ooze through narrow cracks formed in the lava below and the erupted matter above. Thus arise the *fumaroles*, of which mention has been made. All these superficial rocks are porous in a very high degree; and the acid vapours at high temperature decompose the lava, depositing, either on the inside of the cells or cavities of its substance, but sometimes on the surface of the ground, many salts, some neutral, others alkaline; silica also and sulphur, are thus deposited. Within the substance of the large round blocks of cellular lava, sometimes called "volcanic bombs," ejected during the eruption, and often three or four feet in diameter, I saw, on peeling off the surface, considerable deposits of alkaline carbonate of soda. Crystals of several salts of ammonia are also common, and even common salt is met with. On the outside, where the gases emerge, the iron existing in all lava, and carried up with the gases, is deposited very readily in combination with the chlorine and hydrogen, after the first force of the eruption is over. And it is to these deposits of the salts of iron, and not to sulphur, that the intense and brilliant yellow on the face of the crater and surface of the cone are due. They are proofs that the eruptive force has diminished, and that secondary changes are taking place. The form of the deposit is curious. It is usually an incrustation, and often takes the form of small, cup-like, spongy-looking masses, white at the edges, and yellow towards the centre. It is also in groups of crystals. But very soon after it has been formed, and when the acid vapours cease, the warm vapours soon begin to produce further changes, and thus this beautiful appearance is not permanent. Exposed to the air, the iron passes into the state of peroxide; and before long, the white and yellow-coated cells of the stone lose their great beauty and brilliancy, and assume at last that deep brick-red tint familiar to every one in connection with iron rust.

Many and very interesting are the results of chemical investigation in reference to the metamorphoses produced during and subsequent to volcanic eruptions. Such events occurring at intervals, which on a large scale may be regarded as regular, alternate with much longer intervals of apparent repose, during which, however, changes are constantly going on, modifying the materials already erupted, and preparing for the next convulsive and explosive movement.

Whatever mystery may have been imagined to exist in

reference to such movements in the earth is in a fair way of being removed by the investigations of modern chemistry and physics.

Under a certain part of the earth's surface, and within certain limits of time and space, not large compared with the earth and its history, the access of sea-water to cavities existing at a moderate depth beneath the surface of the earth, produces concussive movements or earthquakes, elevations of certain tracts, and the ordinary phenomena of volcanoes. These are produced, in all probability, by very simple means, although the results seem very complicated. They may have nothing to do with any greater depth than a few scores of miles beneath the level of the sea, and they may or may not have reference to the original preparation of the earth as a habitation fit for organized beings. But being now a part of the earth's constitution, they may be studied with great advantage as an important chapter of its history, for they appear to be the chief proximate causes of those great physical features of our globe, on which all the phenomena of organization depend.

Viewed in this light, the account of a volcanic eruption, even though not one of the first magnitude, may possess great value, and the more so since there cannot be a doubt that much remains to be learnt by the chemist concerning the actual succession of events on such an occasion. The mere fact that sulphur is not always, perhaps is rarely, a common product, is one of great interest; and the additional fact that what has certainly been very often taken for sulphur is a salt of iron, and a proof that the eruption is beginning to die out, is equally important. The great volume of cloud commonly issuing from a volcanic vent certainly consists of eighty or ninety per cent. of steam; and the small proportion of muriatic acid, carbonic acid, and nitrogen sufficient to render the steam noxious has been too little attended to. Craters in eruption, and immediately afterwards, are by no means always so easy of access as in the case before us.

The condition of the lavas erupted last year from Etna is very interesting. Among the specimens procured within the first six months from the first outburst were some illustrating every variety known. They include the most scoriaceous and the most compact, the most and the least crystalline, the most felspathic and the most basaltic, some are intensely black, some of the most delicate grey. The successive flows are stratified, and exhibit lines of vesicular and tufaceous composition between the strata. The eruption, in fact, included all the ordinary phenomena, and was not wanting in any of the incidental horrors which are too apt to mark such events. Some time after the original fissure was filled up with the cooling

lava, and the flow had stopped, a sudden and terrible earthquake took place in the immediate vicinity, by which a large proportion of the inhabitants of a village were destroyed. A yawning chasm opened beneath the village, and the miserable people were absolutely engulphed as this chasm partly closed.

Some estimates were taken of the flow of the lava at the commencement of the eruption, which may be interesting and useful for future comparison.

At 200 metres from the fissure from which the lava issued, its mean velocity was estimated at ten metres per minute. This was shortly after the commencement of the eruption, and at this time it was calculated that between 5000 and 6000 cubic metres (say 12,000 to 15,000 tons) were poured out per minute. At this rate nearly eight millions of cubic metres per day would have issued, but the number of points of issue increased, and it was estimated that by the 4th of February (six days after the eruption commenced), more than 112 millions of cubic metres had been poured out (about 300,000,000 tons). The lava descended along the slopes of the mountain for about six and a half miles with unusual rapidity, averaging one and a half mile per day, but its course was fortunately checked at a very early date, and before reaching any of the villages on the mountain side, it had finished its work. It remains now visible at a great distance, and marking the event of which it is the most permanent result.

Messina, *February* 3, 1866.

MR. BROWNING'S REFLECTING TELESCOPE.

At the Soirée given in January by Mr. De La Rue, Mr. Browning exhibited a telescope made for Mr. Slack, which presents important new features, and was much admired. Mr. Browning also read a paper at the Astronomical Society in January, on a new mode of mounting silvered glass mirrors of moderate dimensions, and a new method of suspending the small reflector, or prism, whichever might be employed.

We now lay before our readers a sketch of the telescope made for Mr. Slack. It is furnished with a beautifully-worked mirror of rather less than 6½-inches diameter, made by Mr. With, who has been singularly successful in this difficult and delicate branch of optical art. The way in which the mirror is

SILVERED GLASS MIRROR TELESCOPE ON EQUATOREAL STAND, MADE BY MR. BROWNING FOR MR. BLACK.

supported will be understood from the annexed diagram. The bottom of the mirror, A, is ground to an approximately

true surface, and the same thing is done with the bottom of the inner cell, B, on which it rests. Adjustments of parallelism, etc., are made by means of the screws, D D and E E; and the mirror, with its cell, can be removed from the telescope and replaced with the greatest facility, without loss of adjustment. A tight-fitting brass cap closes the inner cell, and keeps the silvered surface safe when out of use.

The reflecting prism or flat is supported, as shown in the appended diagrams, by means of thin strips of chronometer-

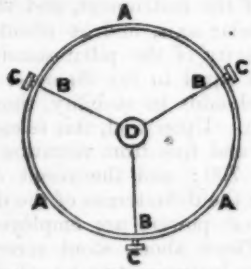


Fig. 1.

Fig. 2.

spring. Fig. 1 gives a sectional, and Fig. 2 a perspective view. These two contrivances—the cell for the speculum and the support for the prism or flat—of Mr. Browning appear, from the trials given to them in Mr. Slack's telescope, to answer their purposes exceedingly well. The President of the Astronomical Society expressed a doubt whether the cellular plan of mounting the mirror would answer for large instruments; but, if it performs well up to seven, or eight, or ten and a quarter inches (the last being the largest size to which Mr. Browning has yet adapted it), its importance will stand very high. The new system of mounting the prism or flat has great advantages. The three slender springs do much less optical mischief than the single stout arm previously employed, and contribute, with the excellent working of Mr. With's mirrors,

to remove the defective definition which reflectors usually give of large stars. In Mr. Slack's instrument, the definition closely resembles that of a fine refractor, and the discs are remarkably small.

The Equatoreal stand was constructed according to suggestions given by Mr. Slack, the details being entirely arranged by Mr. Browning. The special ends in view were, great stability, with convenience and economy. Hitherto, moderate-priced stands have usually been of comparatively slight construction; and, though many of them possess considerable merit, none of them seemed adapted to carry a somewhat heavy and bulky telescope. It will be seen, from the drawing, that the base of the new stand is very compact and solid. It is, in fact, a stout cast iron tube. The circles are twelve inches in diameter, reading to 1′ of an arc, and 2½ seconds of time. The declination circle has considerable weight, and thus effectively assists in counterpoising the telescope. The tube of the telescope divides into two parts, each furnished with a flange fastened by screws to stout rings supported by a heavy arm. By this means the principal weights are exactly opposite each other in every position of the instrument, and they are kept near the centre of the polar axis, and at about equal distances from the centre of gravity of the pillar-stand. The hour angle motion has bearings equal to the diameter of the hour circle, twelve inches, which adds to stability, though at the cost of a little extra friction. Upon trial, this telescope is found to be remarkably steady and free from vibration under a power of between 600 and 700; and the result of this steadiness is very conspicuous in the definiteness of the division of double stars, when the lowest powers are employed that can produce such a result. Three short, stout screws run through the base, and enable the instrument to be adjusted to the indications of two spirit-levels, one of which is shown in the figure.

The eye-piece and prism or flat revolve so that the awkward positions to which an observer is subjected when an ordinary reflector is mounted equatoreally are completely obviated.

That these silvered glass telescopes will come into favour cannot be doubted, as they cost only a fraction of the price of reflectors capable of doing the same work; and perform to the satisfaction of observers like Mr. Webb, who has tried a good many, Mr. Cooper Key, Mr. Bird, and others. We must, however, caution our readers against unreasonable expectations, which we know have in some cases led to great disappointment. In the first place, if an observer who is acquainted with refractors, but has never used a reflector, gets one, and the slightest derangement occurs, he will most likely

have to serve a little apprenticeship in order to learn exactly what to do, and nothing is easier than for an unpractised hand to make a small fault ten times worse by mistaken efforts to get rid of it. Another thing is, that observers who have been using three or four-inch refractors are sometimes apt to expect that reflectors of two or three times those apertures will show *all* objects much better. Now they will not do this; neither will the same sized refractors. Large apertures, if good, give smaller discs, and thus permit the separation of closer stars. They render faint objects visible that were invisible with smaller instruments; and they bring out in the moon and planets details not to be made out with smaller means. But they do all these good things at the expense of taking in a larger space of *disturbed* air; and, except on favourable nights, the disadvantage arising from this circumstance is often so great, that it is advisable to reduce the aperture by stops when looking at bright objects. If a small aperture shows a double star well—that is, light enough, clear enough, and well divided—a larger one will seldom show it better, and often worse. The 6½ size of Mr. With's mirrors, *in good weather*, will *notch* γ^2 Andromedæ, which is an excellent performance; and they find no difficulty at all with stars like η Coronæ, when the atmosphere is favourable. Larger sizes, under appropriate circumstances, will, of course, do more.

We would give another caution to telescope-buyers. Do not spend much money on large mirrors or object-glasses, and then ill-use them by mounting them on bad stands. A recent experiment showed that γ Leonis was far better shown with a power of about 100, and the stand made for Mr. Slack, than with a mirror of the same size, and between two to three hundred magnification, on a shaky stand. In like manner the four stars of ϵ Lyræ are more clearly seen with between 80 and 90, and a well mounted instrument, than with 250, and a badly mounted one. Economy is an excellent thing, and we are glad Mr. Browning has taken so much pains to provide for it; but if an observer only intends spending a given sum, we recommend him to apportion it so that he may get a thoroughly good stand, though so doing may oblige him to be content with a smaller mirror.

MR. WENHAM'S NEW BINOCULAR.

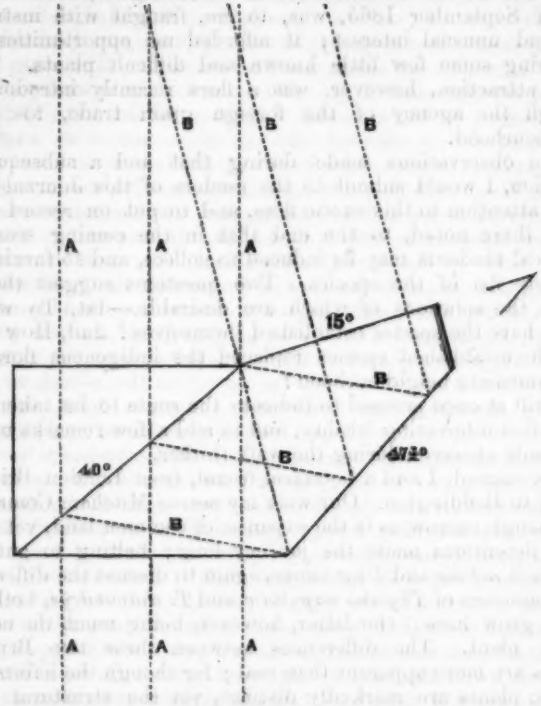
At the Soirée of the Microscopic Society, Mr. Wenham exhibited a Binocular Microscope intended for use with the higher powers, having a new form of prism by means of which the whole of the aperture of the object-glass is transmitted into each eye. In our last number we described a binocular arrangement, invented by Messrs. Powell and Lealand, by means of which this result was first obtained. The main fault of this arrangement is the difference in the intensity of the two images, as the quantity of light reflected from the first surface of a well polished plate of glass, set at an angle of 45° is only $\frac{1}{19}$th part or 53.66 out of 1000 of the incident rays. In Mr. Wenham's plan the light is obtained by combining *two* internal reflections, and the result is such that the image is nearly of equal intensity in both bodies of the microscope, the eye not being able to detect any difference. The first experiment tried by Mr. W. with the view of increasing the light was by means of two small right-angled prisms with their diagonals in contact, this formed a cube with parallel sides, and was placed behind the object glass and slightly tilted beyond the range of total reflection, so as to allow the rays from the object to pass directly through; the transverse reflection from the *two* contact surfaces was thrown into the required eye-piece by means of another right-angled prism. But eventually the preference was given to the annexed arrangement, as it is very compact and fits into the slide of the usual binocular microscope without any alteration being required in the instrument itself.

Its main feature consists of a prism similar to the now well-known form but with the angles slightly more inclined, so as to allow a portion of the rays to pass through the first reflecting surface instead of being totally reflected therefrom; barely in contact with this surface is another prism whose upper plane is parallel with the base of the main prism, the rays from the object-glass will thus pass through without refraction or displacement, and the rays reflected from the *two* surfaces will be again reflected into the opposite body just in the same way as in the ordinary binocular microscope. The surfaces of the two prisms being almost in absolute contact both reflected images are thrown to the same point so that there is no appearance of a double image. The following illustration shows the prisms four times the real size, with the angles employed by Mr. Wenham, and of which he has furnished us with particulars; all the angles are measured from the base.

A, A, rays transmitted direct; B, B, portions of the same rays reflected into the oblique body as usual. As the rays are incident upon the back of the prism within the angle of total

reflection, this surface should be silvered, in the same way as the binocular prisms supplied by Ross.

It might be inferred that no stereoscopic effect would be obtained from the combination of similar images, but it is found in practice that by drawing the prism more or less out,



considerable latitude is obtained this way, and we have Mr. Wenham's authority in stating that the markings on the most difficult test appear in perfect relief with the highest powers, and that sufficient control over the relative direction of vision can always be obtained so as to give the desired result. This arrangement appears to remove all difficulties with respect to obtaining binocular and stereoscopic vision with the higher powers, from the $\frac{1}{4}$th upwards; with the lower powers the perspective effect is not nearly so good as with the old arrangement; for this reason and a certain deficiency of light in both eye-pieces, the latter will be found preferable and more agreeable in use when such powers are employed.

FLORAL IMMIGRATION AT MITCHAM, SURREY.

BY RALPH TATE, F.G.S., ETC.

A BOTANICAL ramble to Mitcham and Beddington, on the last day of September 1865, was, to me, fraught with instruction and unusual interest; it afforded me opportunities of mastering some few little known and difficult plants. The great attraction, however, was a flora recently introduced, through the agency of the foreign grain trade, to this neighbourhood.

The observations made during that and a subsequent excursion, I would submit to the readers of this Journal—to direct attention to this exotic flora, and to put on record the plants there noted, to the end that in the coming season, botanical students may be induced to collect, and so furnish a complete list of the species. Two questions suggest themselves, the solutions of which are desirable,—1st, To what extent have the species established themselves? 2nd, How far have the established species replaced the indigenous flora of the immediate neighbourhood?

I will at once proceed to indicate the route to be taken to reach this interesting locality, and to add a few remarks upon the plants observed during the walk thither.

We started, I and a botanical friend, from London Bridge by rail to Beddington. Our walk lay across Mitcham Common and though narrow as is the expanse of common land, yet frequent detentions made the journey long; halting to gather *Anthemis nobilis* and *Ulex nanus*, again to discuss the differential characters of *Thymus serpyllum* and *T. chamædrys*, both of which grow here; the latter, however, being much the commoner plant. The differences between these two British thymes are more apparent than real; for though the habits of the two plants are markedly distinct, yet the structural differences appear to me only differences in degree. Staying awhile attracted by the blossoms of *Hieracium pilosella*, flowering, as was the case with many vernal species, for the second time during the year, we continued on our way until arrested by the dried-up bottom of a small pond, on the verge of the road near the entry of the lane leading by the tavern. The plants collected here were, *Nasturtium palustre*, *Myosotis cæspitosa*, *Mentha pulegium*, *Chenopodium rubrum*, dwarf variety (abundant), etc. This *Chenopodium* in the *Flora of Surrey* is given under the name of *C. botryoides*, but Mr. H. C. Watson writes in the *Journal of Botany*, p. 78, March 1866, concerning this plant, that "it is really a state or variety of *C. rubrum*, and

not the true *C. botryoides* of the south-east coast." This variety is recorded in the *Surrey Flora* from several localities, the habitat being "margins of ponds frequented by geese;" the additional locality at Mitcham offers no exception to the observed occurrence of this form. Query, Is this attachment of the plant to the haunts of the goose accidental or not? Do the geese feed upon it and so dwarf it?

Proceeding down the lane, I observed growing in the hedge and ditch sides near the inn, *Hyoscyamus niger*, *Solanum dulcamara*, *S. eu-nigrum*, (*S. miniatum*, with its red berries, should be looked for), *Polygonum nodosum*, *P. hydropiper*, *P. convolvulus*, and *Arctium majus* and *A. intermedius*. My companion pointed out to me a character by which *Arctium majus* may be distinguished from its allies, at least, the character is valuable as a preliminary test; the petiole of *A. majus* is solid, whilst that of *A. intermedius* is fistulose. The basal leaves of the species of this genus should be studied.

Further down the lane, I gathered *Chelidonium majus*, *Sison anomum*, *Bidens cernua*, *Inula dysenterica*, *Chenopodium polyspermum* β *acutifolium*, *Poa nemoralis*, and some blackberries. I certainly preferred the fruit of *Rubus corylifolius* to that of *R. discolor*.

At a distance of some two or three hundred yards from the inn, the goal is reached. Entering a gate on the right hand side of the road, easily to be remembered by the arrow of Her Majesty's Surveyors cut on the post, we are at once amongst the refuse of foreign grain, which has been brought to this spot from Wandsworth, and turned out in a continuous heap down the centre of the grass field. Few specimens were gathered here, for some recent alterations had destroyed the mass of the plants; however, *Setaria viridis*, *Serrafalcus arvensis*, *Amaranthus retroflexus*, *Plantago arenaria* (posesses a distinct stem), *Malva parviflora* (known by its small flowers), and *M. flexuosa* (resembling the former, but easily distinguished by its pubescent carpels), were collected.

Following the bridle road, we passed a small pond, on the margins of which were seen growing *Senecio erucifolius* and *Lathyrus nissolia;* some yards beyond this is a small cottage, and in the waste grounds near, much of the corn refuse had been thrown; here we found numerous plants, such that the most casual observer would at once pronounce to be un-English. From these heaps many species have diffused themselves into the corn-field adjoining. These two localities have yielded to me the following species:—

Of the Cruciferæ, *Sinapis alba* is common, *S. dissecta* may be expected to be found, it has pinnatripartite leaves, with pinnatifid lobes; a few plants of *Diplotaxis erucoides*, the

flower of which is strikingly handsome, the coloration is that of a purple or lake Maltese cross on a cream-coloured ground; *Erysimum orientale* and *Erucastrum* complete the list of cruciferous plants.

The Leguminosæ constitute a very large proportion of the flora, being specifically and numerically strong; the genera, *Trifolium*, *Medicago*, and *Melilotus*, being well represented in species and individuals. *Melilotus sulcata* is abundant; this species is readily distinguished from *M. parviflora*, which accompanies it, for in the former the pods are ornamented with arched ribs, whilst in the latter the surface of the pod is irregularly wrinkled; the species differ much in appearance; *M. messanensis* is a large podded plant, the racemes are few flowered. The clovers are represented by three species. *T. resupinatum*, with its prostrate branches bearing woolly globular heads, was found covering a circular space of two feet in diameter. *T. hybridum* is rare; it resembles *T. repens*, but is much larger, and erect; the calyx teeth are setaceous, and the veins of the leaf, which are very numerous, denticulate the margin. The third species is closely allied to *T. supinum*, many specimens were met with. A very interesting series of *Medicagos*, exhibiting great variation in the form and armature of the legumes, occur. The most frequent is *M. denticulata*, var. *apiculata*; *M. maculata* is common, the leaflets wanting the coloured spot in the centre; *M. ciliaris*, with its globose helix, is rare. A single specimen of *Arthrolobium scorpioides* was found. A genus, *Scopiurus*, unknown in the indigenous flora of Great Britain, is represented at Mitcham by a single species, *S. subvillosa*, of rare occurrence. The genus is characterized by its lomentaceous pod and its entire attenuated leaves. One of the most widely-dispersed of these exotics is a herbaceous species of *Ononis*, *O. mitissima*.

Ammi visnaga and *A. majus* are not rare. The genus is unrepresented in the native flora of this country; it gives its name to a tribe, but has the habit of a *Daucus*. The other Umbelliferæ observed were *Caucalis daucoides* and *Torilis nodosa*.

The order Compositæ is well represented:—*Barkhausia setosa*, a few plants; *Centaurea solstitialis*, several specimens; an individual of *Pinardia coronaria*, the genus is perhaps not distinct from *Chrysanthemum*; the curious genus, *Calendula*, of which the garden marigold is a good example, is represented by a small wiry plant, *C. arvensis*; a chicory, apparently *Cichorium glabratum*, is not unfrequent.

Linaria elatine, *L. spuria*, *Anagallis cærulea*, and *Euphorbia platyphylla*, are very abundant, they are all, without doubt, natives; this locality is a new station for the last-named species.

Plantago lagopus was seen among the vegetation of the waste heaps. Its exceedingly woolly heads enable one to distinguish it at a glance from *P. lanceolata*. *Amaranthus retroflexus* is common. *Polygonum arenaria* has an erect, slender stem, and though closely resembling *P. aviculare*, is not an inelegant plant; it is rare. A *Rumex*, closely resembling *R. scutatus*, is very common.

Chenopodiaceous plants are in great profusion. The species are:—*Chenopodium olidum*, *C. polyspermum*, *C. murale*, *C. urbicum*, *C. album* β *viride*, and *C. opulifolium*, the latter species is closely allied to *C. album*; *Atriplex rosea*, a somewhat erect plant, with a buff-coloured stem. The grasses found were *Setaria viridis*, *Phalaris canariensis*, and *P. aquatica*, the latter is known by the lacerated edge of the wings of the glumes, and *Serrafalcus arvensis* and *S. patulus*.

Several of the species mentioned above are known British plants, and as they grow about the rubbish heaps, it is difficult to decide whether they are indigenous or not to this locality; but I had some means of judging whether a species had claim or not to rank among our native weeds; for though many exotics had extended themselves into the neighbouring cornfield, yet I observed that they diminished in numbers, and finally disappeared as the distance from the refuse heaps increased. The species collected during the two visits are arranged in the following lists, one list giving the species that have evidently been introduced with the foreign grain, and a second, including the British plants associated with the former:—

List I.—Introduced Species.

1. Sinapis alba.
2. Erucastrum.
3. Diplotaxis erucoides.
4. Erysimum orientale.
5. Trifolium resupinatum.
6. ——— hybridum.
7. ——— supinum?
8. Melilotus parviflora.
9. ——— sulcata.
10. ——— messanensis.
11. Medicago denticulata var. apiculata.
12. ——— maculata.
13. ——— ciliaris.
14. Ononis mitissima.
15. Scorpiurus subvillosa.
16. Arthrolobium scorpioides.
17. Malva parviflora.
18. ——— flexuosa.
19. Ammi visnaga.
20. ——— majus.
21. Caucalis daucoides.
22. Barkhausia setosa.
23. Calendula arvensis.
24. Pinardia coronaria.
25. Cichorium glabratum.
26. Centaurea solstitialis.
27. Plantago lagopus.
28. ——— arenaria.
29. Rumex scutatus?
30. Chenopodium murale.
31. ——— polyspermum.
32. ——— olidum.
33. ——— album β. viride.
34. ——— opulifolium.
35. ——— urbicum.
36. Atriplex rosea.
37. ———.
38. Polygonum arenaria.
39. Amaranthus retroflexus.
40. Setaria viridis.
41. Phalaris aquatica.
42. ——— canariensis.
43. Serrafalcus patulus.
44. ——— arvensis.

LIST II.—INDIGENOUS SPECIES ASSOCIATED WITH THOSE OF THE FORMER LIST.

1. Torilis infesta.
2. Linaria elatine.
3. ——— spuria.
4. Anagallis cærulea.
5. Anagallis arvensis.
6. Senecio erucifolius.
7. Euphorbia platyphylla.
8. Alopecurus agrestris.

The species of list No. I. are wayside and agral plants of mid-southern Europe. Many of these have been recorded, on the authority of Mr. Irvine, in an appendix to the *Flora of Surrey*, from the banks of the Wandle at Wandsworth. But I have deemed it advisable to give this list, as the species have, at the locality described, a better chance of establishing themselves, and may thus co-mingle with the indigenous plants of the immediate neighbourhood; but before this occurs, while we have the means of determining the source, it would be well to make known the species that are thus introduced, and therefore I urge botanists to visit frequently this locality during the coming season.

In conclusion, I would record the discovery of *Papaver lecoqii*, in a potatoe field, bordering the railway, near the village of Mitcham. *Momordica elaterium*, a cucurbitaceous plant with an elastic fruit, and when ripe squirting out the seeds, on being touched, was found on the road sides between East Croydon and Mitcham. It is there an escape from cultivation; it is grown for the oil that the seeds yield.

GASSIOT'S ELECTRICAL RESEARCHES WITH VACUUM TUBES.

(*With a Coloured Plate.*)

In the March Number of the Intellectual Observer, an attempt was made to represent the extremely beautiful and curious appearance of the electrical discharge from 4000 series of the elements of the voltaic battery, when taken in a vacuum tube, under certain conditions therein described. We now present to our readers another plate with drawings of the discharges as they appear with an increased amount of resistance introduced in the circuit. With the greatest amount through which the discharge will pass, it assumes a faint cloud-like, or nebulous character, slightly stratified in the narrow portion of the tube near the negative glow. As the amount of resistance in the circuit is reduced, the entire length of the positive discharge becomes stratified in cresent-shaped forms as in the figure. The figures in this and in the previously published plate, shew the gradual progress of the discharges.

With the usual voltaic battery, either of Grove, Daniel, or Smee, it is the positive terminal that becomes red-hot—with the discharge from an induction coil it is invariably the negative—and this is also the case with Mr. Gassiot's battery. Many of the tubes with which he has from time to time experimented, have in this manner been destroyed by the heat of the negative wire fracturing the glass, and in one instance in a tube in which balls of aluminium, ¼ inch diameter, were attached to inserted platinum wires, a remarkable result was obtained. The platinum wires attached to the balls were sealed in the vacuum tube about four inches apart, one being attached to the positive, the other to the negative terminal of the battery. The stratified discharges with crescent-formed striæ were then developed. The discharges continued for about one minute, during which time the tube was heated by a spirit lamp; suddenly the negative ball appeared to swell and become red-hot, melting off from the end of the platinum wire—the glass being warm was not fractured by the heated metal, which almost instantly cooled. On examining the tube, it was ascertained the vacuum had in no way altered. The negative ball remained considerably enlarged and shapeless, while the positive was not in the slightest manner changed, the brilliant polish of the metal remaining as when the ball was originally placed within the tube.

Not only is this heating of the negative terminal in itself a curious phenomena of the voltaic discharge in vacuo in contradistinction to the heating of the positive terminal with the voltaic arc in air, but the still more remarkable fact that, how

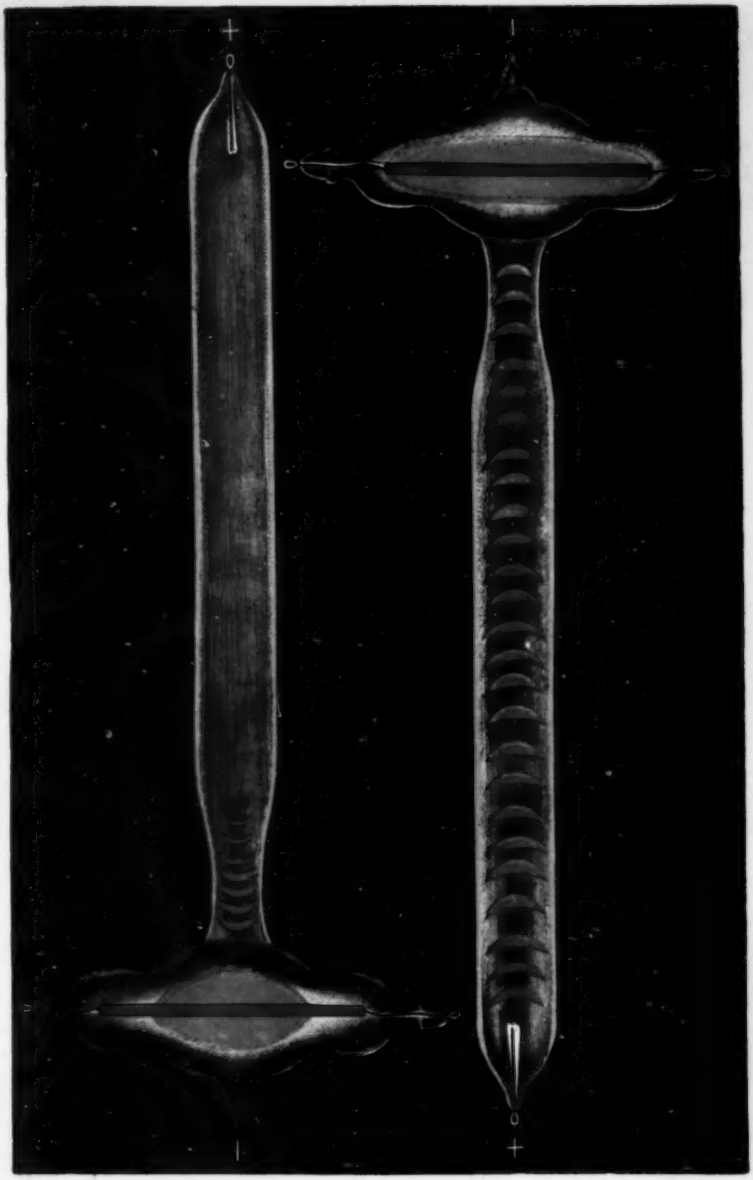
ever long the discharge may continue in vacuo, there is not the slightest perceptible effect in the positive terminal, while the negative will be dissipated in the form of vapour, which vapour is ultimately deposited on the sides of the tube at right angles to the discharge. When a gold leaf is used as a positive terminal, it will during the time of the discharge remain perfectly rigid, and is on subsequent examination found to be in no way changed.

With Mr. Gassiot's battery the discharges can be so modified as to show two experiments, which are very instructive. A vacuum-tube with the potash remaining at one end is introduced in the terminal of 800 cells, without the discharge passing, and in this state the potash is gently heated by a spirit-lamp. Suddenly a luminous discharge will appear, and as the potash is further heated striæ become visible, at first of a large cloud-like appearance, and subsequently very narrow.

By this experiment it is shown that matter is indispensable for electrical conduction, and on the amount of matter depends the shape and appearance of the stratifications.

The other experiment is that which proves that the electrical discharge will not pass through what is termed the magnetic field, or the space intervening between the poles of a magnet. The discharge from 2000 cells was passed through a vacuum-tube showing the usual stratified appearance. In this state the tube was placed in different positions on the poles of a powerful electro-magnet. The discharge was deflected, showing a tendency to rotate round the poles. But when the tube was placed *between* the poles the discharge was instantly extinguished; reappearing as the tube was withdrawn from the magnetic field.

We are indebted to Mr. Gassiot for permission to copy the drawing from which our coloured plate was taken, and he has also allowed us to use his laboratory notes in preparing the preceding account. We are glad to learn that he is engaged in a fresh series of investigations and experiments, which, it is hoped, will further elucidate the very difficult subject of stratified discharges, and when they are completed we shall hope to lay the results before our readers.



ELECTRIC DISCHARGES IN VACUUM TUBE.
Belonging to J. P. Gassiot, Esq., F.R.S.

(Plate II.)

MICRO-SPECTROSCOPE INVESTIGATIONS.

LETTER FROM PROFESSOR CHURCH.

THE Editor has received the following interesting letter from Professor Church.

"Have you tried the experiment with chloride of cobalt, which I mentioned to you? If you take the saturated cold solution of this salt it will give the spectrum roughly sketched in Fig. 1,* a *thinner* film of the *same* solution, heated (on a glass slide with thin cover) over the candle or lamp gives the spectrum drawn in Fig. 2.† You will notice two black bands, I had almost said lines, in the red. As might be predicted from the change of colour on heating, the solution is afterwards much more transparent to rays beyond D. The chloride of copper and nickel also give very interesting results.

But I think you will be most pleased with the experiment I have now to relate. I have worked lately on the spectra of pleochroic minerals and salts. Among the minerals recently examined were several fine specimens of the true zircon or jargoon, a silicate of zirconia. These gave a beautiful and most characteristic system of seven dark bands quite different from those belonging to any other substance yet examined. They are roughly sketched in the following figure. Zircons as colour-

less as common glass shew these bands as well, perhaps better, than those possessed of colour. They are to be observed with zircons which have been ignited as well as with those still in their natural condition. But some zircons show the phenomenon better than others, this difference not being due apparently to the colour of the stone or the thickness through which the light traverses. I am not quite sure, but I incline to think that those zircons which have come from some localities shew the bands better than those from others. Several Expailly specimens scarcely exhibit anything of this kind; all

* The Figure alluded to shews the red darkened, the orange light, and a broad dark band commencing to the right of the yellow and extending beyond the line F, the remainder of the spectrum is cloudy.

† Fig. 2 shows the narrow black bands in the red, modified tints replacing the broad dark band of Fig. 1, the blue coming out clear. The experiment is a very beautiful one.

those from Ceylon and Norway show the bands well. From this observation I am induced to hazard the conjecture that it may be, after all, the presence of Swanberg's *norium* which determines the difference. You are aware that the orange jacinth, a variety of zircon, is very precious, and that the essonite of cinnamon-garnet is constantly sold for it. Curiously enough, the cinnamon-garnet, or essonite, (a lime-garnet), has no conspicuous dark absorption-bands at all, and so the spectroscope may be brought to bear upon the discrimination of these two stones. We have thus a much more ready process than that of taking the density of the specimens. The lime-garnet is of comparatively small value. The iron-garnet of different shades (carbuncle, almondine, etc.) gives a beautiful and very characteristic spectrum with several intensely deep absorption bands.

I write these particulars of my experiments at once, for I thought you might like to make a little paragraph about them for the readers of the INTELLECTUAL OBSERVER.

I ought to add that the absorption bands of zircon resemble those of didymium, discovered by Gladstone, in their sharpness and in their being produced by the passage of light through a colourless medium. Silica, the other constituent of zircon, gives no bands.

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

BY G. M. WHIPPLE.

1866.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M. respectively.		Rain—read at 10 A.M.
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Calculated. Dew Point.	Calculated. Relative Humidity.	Calculated. Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°	0—10		inches.
Jan. 1	29·740	39·3	34·5	·85	·258	43·7	35·0	8·7	0, 0, 1	SW, W by S, SW.	0·284
„ 2	29·912	45·3	39·0	·81	·318	49·7	36·4	13·3	5, 10, 10	S by W, S by W, S by W.	·000
„ 3	29·977	42·4	37·5	·84	·287	47·9	40·3	7·6	0, 5, 9	SW, SW by W, S by W.	·086
„ 4	29·799	47·6	42·4	·83	·344	50·7	41·6	9·1	10, 6, 4	S, S, S.	·020
„ 5	29·870	44·6	42·4	·92	·310	48·8	45·6	3·2	10, 10, 10	SW, N by W, NNW.	·066
„ 6	30·094	37·3	34·3	·90	·240	41·5	35·2	6·3	8, 5, 4	WSW, W, W by S.	·005
„ 7	...	...	...	...	...	50·0	32·9	17·1	...	...	·158
„ 8	29·264	43·5	33·7	·71	·298	48·7	40.8	7·9	3, 8, 6	W, W, W.	·310
„ 9	29·057	34·6	29·4	·83	·218	40·3	34·2	6·1	1, 3, 0	WSW, WSW, WSW.	·036
„ 10	29·226	39·6	34·4	·83	·260	43·7	32·6	11·1	9, 10, 0	W, W, SW by W.	·006
„ 11	29·010	34·3	29·3	·84	·216	36·7	31·9	4.8	10, 10, 2	NE by N, NE by N, N.	†·960
„ 12	29·767	32·4	28·2	·86	·202	36·3	23·6	12·7	10, 1, 2	WSW, WNW, NW by W.	†·253
„ 13	29·568	42·2	37·6	·86	·285	46·5	20·9	25·6	10, 10, 10	S by W, SW by S, W by S.	·084
„ 14	...	...	...	...	...	52·1	39·2	12·9	...	...	·198
„ 15	30·009	45·5	37·7	·76	·320	49·8	44·3	5·5	1, 1, 2	WSW, W by S, W by S.	·156
„ 16	29·761	48·2	43·7	·86	·351	51·2	41·1	10·1	10, 6, 8	SW by S, W by S, WSW.	·130
„ 17	30·172	47·4	44·6	·91	·341	51·7	40·1	11·6	10, 10, 8	SW by S, W by S, W by S.	·045
„ 18	30·050	46·4	44·4	·93	·330	49·5	43.1	6·4	10, 10, 10	SSW, SW, SW by S.	·035
„ 19	29·744	47·2	40·6	·80	·339	51·2	45·7	5·5	2, 9, 3	WSW, SW, SW.	·108
„ 20	29·655	47·1	42·6	·86	·338	51·5	44·1	7·4	8, 7, 9	SW, W, NW by W.	·127
„ 21	...	...	...	...	...	52·7	38·8	13·9	...	...	·020
„ 22	29·774	50·7	49·2	·95	·382	53·7	48·3	5·4	10, 10, 10	SW, SW, SW.	·000
„ 23	30·252	45·8	38·4	·77	·323	49·4	40·7	8·7	3, 3, 6	NW by W, NW, WNW.	·230
„ 24	30·598	40·5	36·5	·87	·269	45·9	32·6	13·3	0, 8, 3	SW by W, NW, W.	·000
„ 25	30·630	40·6	37·3	·89	·270	43·7	33·5	10·2	9, 10, 8	SW, W by S, —.	·000
„ 26	30·572	39·3	37·8	·95	·258	43·8	30·3	13·5	10, 8, 10	—, SW, —.	·008
„ 27	30·326	40·1	36·2	·87	·265	41·9	33·0	8·9	10, 10, 7	NW by N, N by E, E by S.	·000
„ 28	...	...	...	...	...	48·7	38·5	10·2	...	...	·000
„ 29	29·839	43·3	30·7	·64	·296	45·8	43·4	2·4	1, 7, 2	W, W by N, WNW.	·052
„ 30	30·046	40·8	37·1	·88	·271	44·8	35·0	9·8	8, 10, 10	ESE, E, E by N.	·000
„ 31	29·530	47·5	44·8	·91	·343	49·5	38·1	11·4	10, 10, 2	SSE, S, SW by S.	·007
Daily Means.	29·860	42·7	37·9	·85	·294	...	...	9·7	...	...	3·384

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.
† Rain and melted snow.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—JANUARY, 1866.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																
A. M. 12	7	10	42	17	15	3	10	14	17	16	16	8	3	14	27	14	13	18		28	4	30	11	5	4	2	4	10	16	8	8	13·0
1	11	8	38	15	11	3	13	15	17	15	24	7	2	14	25	13	13	11		25	5	22	9	4	6	1	3	11	16	8	12	12·6
2	18	11	25	17	16	2	15	20	18	14	22	8	1	14	33	12	13	15		27	10	23	9	5	5	3	3	7	14	7	11	13·3
3	12	11	24	18	10	3	22	23	18	13	18	5	4	15	30	15	11	20		33	10	25	8	3	6	3	4	12	14	5	9	13·5
4	15	14	22	24	15	4	25	29	15	17	20	2	10	16	15	17	10	15		30	12	25	12	3	7	2	4	9	18	4	8	13·9
5	18	11	21	19	14	3	30	24	13	14	20	1	16	18	18	20	8	15		29	9	25	10	4	6	1	3	5	16	2	9	13·4
6	12	6	21	26	11	2	35	27	11	16	10	10	19	23	17	20	8	15		24	5	27	15	4	6	1	1	5	17	3	13	13·7
7	8	11	12	25	12	2	35	25	16	17	30	7	26	27	17	21	6	18		19	11	26	12	4	4	1	2	9	13	3	18	14·6
8	11	16	10	24	12	2	40	27	14	16	22	5	25	21	19	23	12	18		19	18	28	11	5	5	0	2	10	12	1	18	14·9
9	8	16	10	26	10	2	27	28	16	15	24	5	29	23	19	30	15	23		23	19	25	14	5	6	1	1	13	15	3	17	15·6
10	11	15	11	23	10	4	19	29	18	20	28	10	28	28	17	24	15			24	22	20	14	5	5	4	1	16	18	5	18	16·0
11	13	20	12	20	9	3	19	30	19	18	30	12	30	32	21	25	20		20	23	27	21	13	5	5	2	1	18	23	9	18	17·3
12	17	23	15	23	10	4	15	33	21	22	37	12	27	33	17	19	20		23	24	29	23	16	8	7	1	2	18	24	8	20	18·3
P. M. 1	14	27	13	22	12	4	20	32	24	18	34	10	20	30	16	18	18		22	13	27	23	11	8	7	3	5	20	25	7	19	17·4
2	17	24	11	22	8	5	18	33	21	18	32	10	18	31	19	18	21		18	12	26	21	11	6	6	2	3	18	25	9	18	16·7
3	13	27	10	19	7	3	16	30	19	12	30	8	17	30	11	18	20		15	14	23	18	7	5	5	1	2	15	19	8	17	14·6
4	12	23	7	17	5	4	17	26	18	3	29	8	12	28	13	19	15		19	7	25	14	9	4	6	3	3	15	18	7	17	13·4
5	13	32	8	20	3	4	16	24	16	5	28	5	10	30	11	17	16		15	5	28	12	7	3	5	1	4	11	15	9	18	13·0
6	15	36	12	19	4	4	13	29	16	5	27	5	9	33	15	19	15		17	7	26	9	9	2	4	4	6	13	10	10	17	13·7
7	14	36	11	21	5	5	14	24	13	4	22	3	11	33	12	25	13		18	3	28	9	12	3	5	5	10	13	13	12	20	13·9
8	14	39	12	23	3	6	15	24	11	1	15	4	11	34	14	26	13		19	4	32	10	9	3	4	5	8	14	13	9	18	13·8
9	11	39	18	21	4	5	16	21	14	4	13	3	14	30	12	20	13	553	24	3	34	9	7	4	4	5	9	15	11	11	17	13·7
10	12	40	17	21	5	11	15	25	13	9	9	3	16	45	12	14	17		26	5	26	11	9	6	4	7	7	16	10	11	19	14·7
11	11	37	18	19	2	8	15	18	14	9	5	4	14	28	11	12	17		23	2	22	12	7	5	3	3	8	15	8	7	15	12·4
12																																
Total Daily Movement.	307	532	400	501	213	96	480	610	392	301	545	155	372	630	421	459	342	1004		402	478	468	252	109	125	61	96	308	383	166	374	14·7

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1866. Day of Month.	Reduced to mean of day.		Calculated.			Temperature of Air.			At 9·30 A.M., 2·30 P.M., and 5 P.M., respectively.		Rain—read at 10 A.M.
	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	
	inches.	°	°		inch.	°	°	°	0—10		inches.
Feb. 1	29·329	50·5	48·1	·92	·380	55·2	46·3	8·9	9, 10, 10	SSW, SW, SW.	0·329
„ 2	29·464	48·3	42·8	·83	·352	53·5	47·0	6·5	10, 9, 2	N, W, W.	·380
„ 3	22·659	42·7	38·4	·86	·290	49·4	37·5	11·9	7, 9, 9	SSW, W, W.	·015
„ 4	...	...	...	...	...	51·5	37·3	14·2	...	... ...	·257
„ 5	29·966	45·5	36·7	·74	·320	54·1	39·5	14·6	2, 8, 8	W, W by S, WSW.	·372
„ 6	29·823	50·7	42·6	·76	·382	54·7	43·8	10·9	1, 3, 5	SW, W, WSW.	·013
„ 7	29·627	49·0	40·8	·75	·361	54·8	50·8	4·0	10, 3, 2	W, W, WSW.	·024
„ 8	29·942	42·6	33·8	·73	·289	47·2	38·9	8·3	3, 2, 0	SW by W, W by S, W by S.	·080
„ 9	29·699	48·1	46·8	·96	·350	52·0	40·4	11·6	10, 10, 10	SSW, SSW, SW by S.	·019
„ 10	29·526	46·9	40·6	·81	·336	50·7	42·5	8·2	6, 3, 6	SSW, SW, SW by W.	·392
„ 11	...	...	...	...	...	48·3	41·9	6·4	...	... ...	·190
„ 12	29·414	40·7	32·6	·75	·271	44·0	39·5	4·5	9, 8, 2	WSW, W by N, W by S.	·357
„ 13	29·717	37·1	25·0	·65	·239	44·0	30·6	13·4	7, 0, 0	NW by W, W, W by N.	·000
„ 14	29·568	39·4	35·6	·87	·259	44·8	28·4	16·4	10, 10, 10	S by E, S, S.	·000
„ 15	29·496	39·1	32·8	·80	·256	44·0	31·5	12·5	10, 9, 10	SW by W, W by S, W by S.	·227
„ 16	29·510	42·9	42·2	·97	·292	45·1	37·2	7·9	10, 10, 10	SW, NE, —.	·356
„ 17	29·882	37·2	31·8	·83	·239	38·7	37·3	1·4	9, 10, —	NNE, NNW, —,	·185
„ 18	...	...	...	...	...	40·3	26·0	14·3	...	... ...	·004
„ 19	30·045	37·4	29·9	·77	·241	43·5	27·8	15·7	0, 0, 4	—, —, —.	·000
„ 20	30·023	37·8	30·5	·77	·245	41·8	24·6	17·2	10, 3, 3	SW, N by E, NNE.	·000
„ 21	30·282	38·6	33·0	·82	·251	42·7	28·5	14·2	8, 3, 6	NNE, N by E, N by E.	·000
„ 22	30·073	39·6	37·8	·94	·260	45·3	27·2	18·1	10, 10, 8	SW by S, SW, SW by W.	·000
„ 23	29·757	45·5	38·2	·77	·320	50·9	33·0	17·9	10, 8, 4	SW by S, W by S, W.	·012
„ 24	29·944	40·3	28·3	·65	·267	44·8	34·2	10·6	0, 3, 4	W by N, W by N, WNW.	·000
„ 25	...	...	...	...	...	46·5	38·4	8·1	...	... ...	·037
„ 26	29·368	38·1	34·8	·89	·247	42·9	36·2	6·7	10, 6, 3	SSE, W, —.	·080
„ 27	29·432	34·3	31·2	·90	·216	36·9	32·2	4·7	10, 10, 10	N, NE by N, NE by N.	·389†
„ 28	29·263	32·4	27·6	·84	·202	36·0	30·4	5·6	10, 10, 8	NW, NNE, N by E.	·000
Daily Means.	29·700	41·8	35·9	·81	·286	...	...	10·5	...		3·718

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

† Rain or melted snow.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—Feb., 1866.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	Hourly Means.
Hour.																													
A.M. 12	16	24	9	13	14	24	24	15	9	11	19	27	6	5	3	18	10	2	3	3	11	1	5	6	22			15	12·1
1	11	19	7	9	11	25	24	20	9	10	18	25	5	5	5	17	8	2	2	1	13	1	5	5	24			19	11·5
2	14	13	11	10	11	23	22	20	6	9	13	22	6	6	5	16	8	2	1	0	13	1	5	5	24			18	10·9
3	17	16	10	13	13	21	23	19	7	9	15	23	5	4	7	19	8	4	3	0	17	1	7	9	24			19	12·0
4	16	16	11	14	12	19	27	22	10	8	15	18	9	5	8	9	5	5	3	0	15	2	6	12	22			18	11·8
5	12	13	12	14	11	16	32	18	13	9	14	15	9	2	5	6	4	3	2	0	18	3	9	10	23			17	11·2
6	10	5	13	14	11	18	26	17	17	10	22	13	6	3	6	5	5	2	3	0	16	5	9	10	23			18	11·1
7	13	17	13	14	10	14	28	18	15	8	25	11	9	2	2	5	5	3	3	0	15	4	11	10	20			16	11·2
8	12	30	16	17	12	17	27	17	17	7	25	11	7	8	4	5	3	4	2	0	15	8	17	12	16			12	12·3
9	16	29	20	19	17	20	30	22	22	6	31	12	11	10	5	5	3	3	2	1	13	12	16	18	15			9	14·1
10	18	14	27	23	16	21	22	23	22	16	40	16	12	11	10	5	13	7	2	7	15	16	22	18	17	7	8	17	15·9
11	19	13	25	29	19	25	20	26	21	18	40	15	15	15	11	2	7	7	4	4	18	20	22	19	15	8	10	21	16·7
12	22	15	29	29	21	26	25	24	25	25	45	16	14	20	15	2	9	8	5	7	19	23	33	19			13	26	19·8
P.M. 1	23	18	30	20	19	29	30	24	24	27	45	13	13	19	12	3	6	8	3	9	19	21	27	21			15	28	19·6
2	25	18	19	20	16	27	32	22	23	27	49	12	12	13	15	2	6	8	4	11	15	17	22	19			17	30	18·5
3	25	16	19	22	13	25	23	20	22	29	44	12	10	27	12	1	5	7	4	9	14	15	20	13			22	30	17·6
4	23	15	15	20	15	22	28	16	21	22	47	8	8	29	11	2	6	5	2	6	13	11	22	14			25	19	16·3
5	19	13	23	21	17	19	20	12	19	20	42	5	4	22	8	3	3	2	3	6	8	7	15	11			25	16	14·0
6	17	13	19	26	14	23	18	12	22	20	42	5	6	23	10	3	5	1	2	5	8	5	7	10			25	15	13·7
7	19	14	16	26	22	25	17	10	16	20	34	4	9	28	9	5	5	5	2	8	4	5	9	13			24	10	13·8
8	20	11	19	27	24	26	15	8	12	17	28	6	8	16	14	7	3	5	0	8	3	5	7	13			26	4	12·8
9	21	14	16	30	28	25	15	9	9	24	29	6	3	11	15	7	3	2	2	9	0	6	6	13	158	122	20	6	12·7
10	22	13	16	23	28	27	16	10	10	22	30	5	9	8	16	8	3	2	3	9	2	4	6	17			22	8	13·2
11	21	8	14	19	22	23	16	7	9	18	28	6	5	3	15	9	4	1	1	10	1	5	7	18			22	4	11·4
12																													
Total Daily Movement.	421	377	409	479	396	540	560	411	380	392	740	306	201	295	223	164	137	98	61	113	285	198	315	315		814		395	13·4

RESULTS OF METEOROLOGICAL OBSERVATIONS MADE AT THE KEW OBSERVATORY.

LATITUDE 51° 28′ 6″ N., LONGITUDE 0° 18′ 47″ W.

1866.	Reduced to mean of day.					Temperature of Air.			At 9·30 A.M., 2.30 P.M., and 5 P.M., respectively.		
			Calculated.								
Day of Month.	Barometer, corrected to Temp. 32°.*	Temperature of Air.	Dew Point.	Relative Humidity.	Tension of Vapour.	Maximum, read at 9·30 A.M. on the following day.	Minimum, read at 9·30 A.M.	Daily Range.	Proportion of Sky clouded.	Direction of Wind.	Rain—read at 10 A.M.
	inches.	°	°		inch.	°	°	°	0—10		inches.
March 1	29·520	28·1	25·7	·92	·173	33·8	22·4	11·4	10, 10, 10	NE by E, NE by E, NE.	0·000
„ 2	29·683	33·9	25·5	·74	·213	39·3	27·1	12·2	0, 0, 2	NE, NNE, N.	·004†
„ 3	29·655	33·1	24·8	·75	·207	38·8	25·7	13·1	0, 10 9,	NW by N, NNW, WNW.	·000
„ 4	...	...	...	...	...	40·3	28·0	12·3	...	... ...	·000
„ 5	29·857	34·6	26·0	·74	·218	39·6	31·2	8·4	7, 10, 9	NE, —, S.	·000
„ 6	29·264	37·1	33·4	·88	·239	42·3	32·8	9·5	7, 10, 6	SSE, S, S.	·000
„ 7	29·163	36·8	31·4	·82	·236	42·7	29·1	13·6	1, 8, 3	S by E, —, SE by S.	·093
„ 8	29·549	36·3	31·8	·85	·232	43·4	31·2	12·2	10, 8, 1	NEbyN, NW byW, NWbyW	·000
„ 9	30·021	38·9	31·4	·77	·254	43·9	35·2	8·7	6, 9, 4	NNE, N, NE.	·000
„ 10	30·333	36·8	29·7	·78	·236	42.6	33·2	9·4	10, 8, 7	NE by N, N by E, NE.	·000
„ 11	...	...	...	...	...	45·5	35·1	10·4	...	... ...	·048
„ 12	29·828	41·6	34·2	·77	·279	48·7	34·0	14·7	7, 3, 3	W by N, W, W by S.	·000
„ 13	29·564	36·1	32·1	·87	·230	48·7	33·5	15·2	10, 8, 9	NNE, N, N.	·003
„ 14	29·515	35·0	23·7	·67	·222	...	26·2	...	0, 3, 4	NW, SW, WSW.	·000
„ 15	29·256	38·0	26·9	·67	·246	43·0	30·1	12·9	7, 8, 10	S by E, SSE, S by E.	·000
„ 16	29·191	46·7	38·8	·76	·333	53·1	36·8	16·3	9, 9, 10	SE, SE, SE by E.	·000
„ 17	29·141	44·9	40·0	·85	·313	51·9	41·7	10·2	10, 7, 5	SSE, S, S by W.	·020
„ 18	...	...	...	...	...	52·2	36·5	15·7	...	... ...	·007
„ 19	29·216	41·9	39·6	·92	·282	47·8	40·0	7·8	10, 10, 10	NE by N, NE, NE.	·021
„ 20	29·401	38·8	35·5	·89	·253	42·9	39·9	3·0	10, 10, 10	NE by E, ENE, E by N.	·010
„ 21	29·577	33.7	31·9	·94	·211	38·1	33·0	5·1	10, 10, 10	NNE, NE, NE by N.	·177†
„ 22	29·817	36·7	26·5	·70	·235	44·6	31·5	13·1	5, 4, 3	WNW, N by E, N by W.	·031
„ 23	29·662	42·6	30·4	·65	·289	47·8	34·4	13·4	5, 10, 10	S, S by E, S by E.	·000
„ 24	29·063	44·3	40·1	·86	·307	50·8	37·8	13·0	8, 4, 10	SSW, SW by S, SW.	·422
„ 25	...	...	...	...	...	53·1	44·3	8·8	...	... ...	·070
„ 26	30·179	46·6	43·4	·89	·332	54·6	31·5	23·1	10, 10, 10	S by W, S, S.	·000
„ 27	30·099	52·5	40·1	·65	·406	57·8	45·9	11·9	9, 3, 3	NW by W, W by N, W.	·014
„ 28	30·143	48·7	46·2	·92	·357	55·0	42·2	12·8	5, 10, 10	SW by S, SSW, SW by S	·095
„ 29	30·164	53·9	51·2	·91	·426	60·2	47·4	12·8	9, 10, 10	W by S, SW by S, SSW.	·000
„ 30	...	...	...	...	...	60·7	49·7	11·0	...	... ...	·000
„ 31	29·857	46·4	43·4	·90	·330	52·2	46·0	6·2	10, 9,—	NE, W.	·135
Daily Means.	29·643	40·1	34·0	·81	·271	...	...	11·6	...	...	1·150

* To obtain the Barometric pressure at the sea-level these numbers must be increased by ·037 inch.

† Rain and melted snow.

HOURLY MOVEMENT OF THE WIND (IN MILES) AS RECORDED BY ROBINSON'S ANEMOMETER.—March, 1866.

Day.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	Hourly Means.
Hour.																																
A.M. 12	2		3	2			3	7	15	16	6	6	6	6	5	6	10	9	9	8	17	2	3	21	24	3	11	8	5	18	5	8·2
1	1		3	3			4	9	28	16	6	7	7	7	7	7	8	9	9	11	17	3	3	19	22	1	13	6	8	14	5	9·0
2	1		2	1			6	11	27	16	6	8	6	3	7	9	5	7	8	10	19	5	5	17	24	2	15	5	9	13	4	9·0
3	4		1	3			6	9	30	16	4	7	3	4	10	5	7	8	6	7	21	4	5	16	21	1	15	7	4	9	7	8·6
4	3		4	3			5	7	28	15	4	8	6	3	8	7	8	7	6	7	19	7	8	15	25	1	9	6	5	15	6	8·7
5	2		1	4			4	12	26	17	4	8	9	3	10	8	7	10	8	10	20	4	9	16	23	1	9	5	3	10	6	8·9
6	4		4	5			3	9	29	15	3	7	9	4	14	11	3	12	9	11	23	4	12	16	20	1	15	6	5	9	5	9·6
7	7		3	5			4	10	28	14	2	10	7	4	15	15	3	15	7	10	22	6	16	15	18	1	17	6	3	10	5	9·9
8	9		3	3			5	14	25	16	3	14	13	5	19	15	2	14	11	12	20	7	21	14	18	2	14	9	5	9	4	10·3
9	10		2	4			6	14	25	18	8	12	18	6	28	15	7	11	12	14	19	10	22	20	18	7	15	12	5	10	5	12·6
10	10	15	2	6		34	11	13	26	17	7	14	22	7	30	17	9	16	10	16	17	10	27	25	21	10	12	16	6	13	3	14·7
11	11	17	4	4		28	12	10	25	18	10	18	21	5	31	16	12	17	9	12	16	14	30	26	18	13	17	15	5	12	4	15·0
12		16	4			25	13	12	25	20	11	17	23	6	33	18	18	19	10	16	15	16	34	26	16	14	18	16	9	14	4	16·7
P.M. 1		16	7			24	6	16	23	23	9	18	21	5	29	22	18	20	15	16	17	14	32	24	17	17	18	15	8	11	5	16·6
2		11	7			12	3	3	21	26	6	19	20	7	28	22	21	15	13	18	17	16	35	26	16	18	17	15	7	11	8	15·6
3		13	7			10	11	8	23	24	7	16	20	4	26	25	16	15	12	20	15	4	36	24	14	17	15	18	8	11	7	15·2
4		10	5			8	10	9	24	19	8	20	19	5	25	20	19	11	13	24	16	6	38	27	17	13	14	17	9	9	6	15·0
5		6	3			2	6	9	19	15	6	13	15	3	25	18	19	9	12	22	11	7	33	17	8	10	7	15	8	7	7	11·9
6		7	3			4	4	12	20	11	8	16	15	6	26	14	13	2	13	26	9	4	42	20	5	13	6	12	6	5	12	11·9
7		2	1			7	2	13	21	17	5	11	8	6	22	7	15	5	4	18	7	2	37	17	2	12	5	12	11	3	13	10·2
8		3	4			3	3	12	18	11	6	8	8	6	15	7	11	10	8	15	4	3	38	17	2	15	3	10	11	5	9	9·5
9		4	5	217		3	4	13	17	11	7	7	9	6	15	8	11	8	10	17	4	1	30	16	2	13	4	11	11	8	9	9·4
10	291	3	4		250	4	2	17	17	9	5	10	7	6	20	11	11	8	10	18	3	4	26	20	4	10	5	10	14	5	8	9·7
11		3	3			6	7	15	17	7	5	7	9	5	14	10	9	8	8	17	1	4	24	21	2	11	5	8	10	6	8	8·9
12																																
Total Daily Movement.	481		85		680		140	264	557	387	146	281	301	122	462	313	262	265	232	355	349	157	566	475	357	206	279	260	175	232	155	11·5

THE SMITHSONIAN INSTITUTION.

A CONSIDERABLE interest attaches to the principles upon which public institutions of a scientific character are founded and conducted; and the recent issue of the Annual Report of the Board of Regents of the Smithsonian Institution for the year 1864, enables us to lay before our readers some facts relating to an establishment which has attained world-wide celebrity. The delay in publishing the report for 1864 is due to a fire which destroyed the documents in the secretary's office, besides occasioning other damage.

From an introduction first published in the report for 1847, and now reprinted, we learn that Mr. Smithson left certain property to the United States of America, "to found at Washington, under the name of the Smithsonian Institution, an establishment for the increase and diffusion of knowledge among men." Thus the institution so founded is not considered as a national establishment; but the government of the United States is a trustee, to "a bequest for the benefit of mankind," and for the perpetuation of the testator's name.

It seems to have taken eight years for preliminary consideration how the bequest should be applied; and this fact, so like scores in the old country, indicates pretty plainly whence the people of the new country came. It was at last decided that "the organization should be such as to enable the institution to produce results in the way of increasing and diffusing knowledge, which could not be produced, either at all, or so efficiently, by existing institutions in the country;" and it was further decided, that the arrangements should be susceptible of such modifications as changing circumstances might require.

To stimulate original research, it was proposed to "offer suitable rewards for memoirs containing new truths," and to appropriate annually a portion of income for the prosecution of particular researches, while it was hoped to assist the diffusion of knowledge by the publication of reports on physical science, moral and political science, literature, and fine arts.

The Act of Congress establishing the institution, contemplated, as we are told, the formation of a library and museum; and the Board of Regents at first resolved to divide the income into two equal parts, one of which was to be appropriated for the purposes already mentioned, and the other towards the library and museum, and subsequently rescinded this rule, and determined that the annual appropriation should follow the exigencies of the occasion. Smithson bequeathed for the institution $515,169 00c. upon which interest accumulated

during the eight years' incubation of the scheme. This money was placed in the United States' treasury, at six per cent. interest; and when the war led to a great issue of paper currency, and consequent depreciation of that form of money, the managers of the institution claimed to have their dividend paid in cash, which was acceeded to.

From the Secretary's Report, we learn that James Smithson was a graduate of Oxford, and devoted a long life to the advancement of science. His will did not define the modes in which the property bequeathed was to be employed, but simply laid down the general principles we have named. At first, the notion of applying the bequest to the foundation of an university commended itself to some minds. John Quincy Adams showed that this would not carry out the testator's intentions. The next proposition was to establish a large library and museum; but this plan was abandoned as too local in its influence. The Act of Congress, upon which the institution rests, finally decided that provision should be made for a library, gallery, and museum; but left the details, and the devising of measures to carry out other objects, in conformity with the terms of the bequest, to the Board of Regents.

The first mistake, according to the interesting report of Mr. Joseph Henry, the secretary, was to spend too much on a costly building. It was natural for the citizens of Washington to wish that such a building should be erected, but Mr Henry is probably quite right in his opinion that the Smithsonian funds could not afford it. The building, furniture, and grounds cost 250,000 dollars, spread over a series of years. By economical management in other respects, it was found that at the commencement of the war, the Smithsonian Institution possessed, after paying for its building, library, and establishing a large museum, and carrying on sundry active operations, an extra fund of 140,000 dollars. The secretary reports that it has been discovered that a building of one-fifth of the cost of the present one would have answered the purpose better; and he adds that, as the style chosen was much too expensive for the sum to be appropriated, the interior has been finished in wood and stucco, to allow for the cost of freestone outside.

The mistakes made in this matter closely resemble those we are accustomed to in this country; but notwithstanding all errors, the Smithsonian Institution is a great fact, and contributes very efficiently to the noble purposes of "increasing and diffusing knowledge among men," which its founder desired. The institution issues three classes of publications—a quarto series, *Smithsonian Contributions to Knowledge*, of which the fourteenth volume is nearly through the press; each volume contains one or more articles; an octavo series, *Smithsonian*

Miscellaneous Collections; and another octavo series, *Smithsonian Reports*. The quarto volumes contain elaborate and original investigations and researches; the *Miscellaneous Collections* comprise reports of the present state of knowledge on particular subjects, instructions for collecting and digesting facts, etc.; and the *Reports*, in addition to information concerning the proceedings of the institution, supply abstracts of lectures delivered before it, extracts from correspondence, original and translated articles on scientific subjects. The first two series are extensively presented to institutions and public libraries, exchanging their own publications; while the *Reports*, which contain scientific matter in a more popular shape, are given away with great liberality.

In addition to the publication of the works mentioned, the Smithsonian Institution makes grants in aid of important books. In this way it assisted *Agassiz's Contributions to Natural History*, *Gould's Astronomical Journal*, etc., etc.

The Smithsonian Institution has likewise performed labours analogous to some of those undertaken by the British Association, stimulating "a skilful artisan" to construct standard metereological instruments, and organising a body of observers.

Astronomy, physics, and chemistry, have been promoted by various publications, by the encouragement of observation and experiment, and other means, including the keeping up of a laboratory, at present in use by Dr Wetherell for analyses of air from various public buildings.

Geographical, geological, and natural history researches have been promoted at the expense of the institution; and specimens of various kinds collected by its travellers have been arranged in its museum, and duplicates presented to the museums of other countries.

Previous to the commencement of the war, the lectures given at the institution were well attended; but for the last four years, the attendance was diminished, or was composed of persons "seeking amusement rather than information;" a fact not to be wondered at, when only one institution in London, the Royal, can succeed in tempting any considerable number of persons to attend lectures worth listening to.

From the brief sketch we have given of the "Smithsonian Institution," it will be seen that it occupies a position very different from that of any single body in this country; and by its combination of various kinds of scientific and literary work, it seems admirably adapted to the wants of the United States, in which, though there is an important amount of scientific ability and energy, there are not, as in England, persons of wealth scattered all over the country, and able to avail themselves of various societies and institutions such as we possess.

Our great want in this country is for local museums, and really good libraries. Students who have not frequent access to London, or to one of the few towns in which large well-supplied libraries exist, are very badly off, we might say disgracefully so, when we consider the wealth of the people, and the very small contribution from local taxation that would supply every town of ten or twenty thousand people with the principal works absolutely necessary for the study of physical and descriptive science, archæology, etc.

ARCHÆOLOGIA.

THE value of PHOTOGRAPHY in delineating ARCHÆOLOGICAL OBJECTS is undoubtedly great, especially on account of the quickness with which, by means of this art, we obtain accurate outlines, however elaborate the design; but the assistance thus given by photography is not always satisfactory, and this is especially the case with ancient inscriptions, in which a photograph by no means always replaces the original. Inscribed stones, and indeed any other stones, which have remained several centuries buried in the earth, or exposed to the weather above ground, have always undergone a certain degree of detrition of the surface which must seriously affect the exactness of the outlines inscribed upon them. The injury thus done is, of course, greater or less according to the character of the stone; but it is sometimes so great, that the inscription can no longer be read at all. All who are accustomed to deciphering Roman inscriptions on stone (excepting marble), know the extreme difficulty which they often present even to the most accomplished scholar. He is obliged to look at them at different angles, and therefore in different lights, and with different shades, and even then he only fixes the exact outline which the figure ought to have through his own great knowledge of the subject. How, then, is it possible that the true outline of the letters of such inscriptions can be visible to the eyes of men who are totally ignorant of the language in which they are written, and even of the class of objects to which they belong. Yet a very fatal practice appears to be arising of allowing the letters of such inscriptions to be painted in colours which contrast with the stone itself, we suppose with the idea of thus giving it a more effective appearance. In a communication to the March number of the "Gentleman's Magazine," Dr. Charlton, of Newcastle-on-Tyne, has pointed out the danger of this practice, and described a case in which it has been recently applied to a stone with a Runic inscription, at Baronspeke, near Bewcastle, in Cumberland. He tells us that "last year a photographer, accompanied (we believe) by an antiquary, visited the spot, and it seems that, in order to make the letters more visible, they painted the stone of a black colour, and then actually *retooled*

the whole of the inscription!" So that, as Dr. Charlton justly observes, "we cannot now judge of the original form of the letters." If, however, this is a practice to be blamed in cases where the letters can be read without much difficulty, how much more so must it be where the reading of the characters is so difficult that it has been the subject of a variety of different readings, and has given rise to several contradictory theories. Yet we have not only a recent example of such a case, but we have received a confession of it from the actor in it, who seems to be quite unconscious of the wrong he had been doing. In the March number of the INTELLECTUAL OBSERVER, in noticing Dr. Moore's book on the Newton stone, we remarked that that remarkable monument, since we first saw a drawing and cast of it, had evidently been tampered with, explaining our meaning by adding that, no doubt for the purpose of giving a more distinct photograph, the letters of the inscription had been painted white. In this case, such a proceeding was especially to be lamented, because, as the spirit of our review was to express our opinion that Dr. Moore had entirely mistaken the character of the inscription, we should naturally object to receiving his adjustment of the outlines of the letters, and, if possible, still less that of the photographer, who does not even profess to know anything about it. The latter addresses a letter to our publishers, which we shall simply lay before our readers. Mr. Alexander Riddle, for such is the name signed by the writer, corrects us, as will be seen, in one point only—we learn that the glaring white of the letters was produced, not by paint, but by chalk. It is a satisfaction so far, that the chalk will probably soon wash away, and, *perhaps*, do no injury to the inscription. But, nevertheless, the proceeding was a very wrong one, and we hope not frequently to hear of its being repeated. Here is the letter:—

"In the number of the INTELLECTUAL OBSERVER for this month, there is an article on the 'Newton Stone,' by a 'T. W.,' in which he asserts that the inscription has been tampered with by painting, so as to enable the photographer to obtain a better copy of the characters; so that now, in place of the true inscription, you have only the outline of characters made by the painter. I am the person who did the photographs, and from a copy of which Dr. Moore had the copies taken for his book; but, before they were copied, that gentleman had the satisfaction of seeing the stone in reality, and comparing the copy taken by me, with the real inscription, and had no fault to find with it. I am sure a visit to the stone by 'T. W.' would satisfy him more than any cast or photograph, however perfect, can do. I had gone a distance of nearly thirty miles to take a photograph of the stone, and knowing that it was to go into the hands of many learned men, my object was to take as perfect a copy as I could. Owing to the grey colour of the stone and the grey light I had on reaching it, I saw it was absolutely necessary to try something to give effect to it. After taking a copy as it was, I then took a little *chalk* and rubbed into the bottom of the characters, the cutting of which varies from a quarter to three-eighths of an inch, and could not have much shade

though the sun had been shining. The chalking was a work of great care, and cost me more labour than the photographing did; and I have no doubt the *chalking* all disappeared with the first rain that came after my visit. Hence you see there is nothing you could call tampering with the inscription, as 'T. W.' is pleased to call it. I herewith send you a copy of the inscription without the chalk and one with it, that you may examine for yourselves. I got sunshine for the last one."

Mr. Riddle appears evidently to be under the impression that our remarks implied some personal offence to himself. We only blame him for interfering with what he did not understand, and making any mark whatever, even if it were only with chalk, on a monument of such importance. He was led by a sort of zeal which, however innocent it may appear to one who acts under its influence, requires to be rigidly discouraged; otherwise, some of the most important monuments in our islands run the risk of being defaced and destroyed.

At the last meeting of the Anthropological Society, a series of extremely interesting communications were made on the preserved PRIMEVAL INTERMENTS which had been excavated IN CAITHNESS by Mr. Laing, and form the subject of a recent publication by that gentleman, entitled "Prehistoric Remains of Caithness." Mr. Laing explored these monuments, consisting chiefly of mounds, and near the shore, and found in them remains of human skeletons, numbers of stones, supposed to be worked implements, a few objects in bone and metals, and some walls and structures of stone which are considered to be cists. The discoveries appeared to us to be of no great importance; the stone-work struck us as being of no great antiquity; many of the stones presented the appearance of having been formed merely by breaking and rolling back; and those which were evidently made by man might have been comparatively modern. On the occasion referred to, no less than five communications, from the same number of intelligent inhabitants of the district, all controverting Mr. Laing's facts as well as his conclusions, were read before the Anthropological Society. The first was by Mr. John Cleghorn, of Wick, who alleged that the position of some of these mounds and cists was such as, from the known regular receding of the sea, they could not have been on dry ground more than three or four hundred years ago. The skeletons he conceives to be chiefly those of drowned sailors, who have been cast upon this shore, which appears to have been much exposed to wrecks. The hills and mounds explored by Mr. Laing are represented in these communications as mere accumulations of sand formed upon objects which lay near the shore. One of the more remarkable of these hillocks, which Mr. Laing calls a "moorland mound," was described in one of these communications, by Mr. R. I. Shearer, as a "sheiling bothy," a structure which has been in use in that locality within forty or fifty years. "I can, at least," he said, "find men in Caithness who built 'sheiling bothies' exactly similar to Mr. Laing's 'moorland mound.' The walls being of large flagstones set on edge,' are the same as are to be seen at this day in

many modern buildings similarly situated, where the largest surface that any stone can be got to present is of the utmost importance in a turf building. The shells found on the floor are just such as the young women who attended their cattle in these moorlands were sure to go to the shore to gather, after they had finished their day's work, or were waiting for the return of their cows. . . . . The 'bench, or bed,' along the walls is simply the place on which the milk was set in dishes, a portion of which dishes Mr. Laing found, 'having a coarse blue glaze,' and which he mistook for a piece of pre-historic pottery!" The two large stones opposite the door, in the further end of the building is the fire-place, and these stones, with the assistance of one or two more, though not so permanently fixed, were used for supporting a large pot, in which they boiled their milk for making cheese. . . . . The stones projecting on each side of the doorway, are the foundations of a turf erection merely for shelter. It reached to the height of the walls, and was covered on the top; and, in a day's walk in the interior of the country, I will now point out half a score of similar erections."

The statements contained in these papers were made so authoritatively, and with such an apparently perfect knowledge of the facts, that there seems hardly room to doubt that Mr. Laing has fallen into some extraordinary errors; and, at all events, they warn us to treat discoveries of this kind with a considerable degree of caution and even of hesitation.

T. W.

LITERARY NOTICES.

On the Anatomy of the Vertebrates, Vol. II., Birds, and Mammals. By Richard Owen, F.R.S., Superintendent of the Natural History Departments of the British Museum, Foreign Associate of the Institute of France, etc., etc. (Longmans.)—The second volume of this important work commences with the character of the hæmatotherma, or warm-blooded animals; and Professor Owen remarks that "it is curious to observe that the winter-sleeping and torpid mammals are those which most resemble reptiles in their cerebral organization; they are also of small size." He adds, "no approach to torpidity, with loss of animal temperature, has been determined to take place in any bird," which is remarkable, as in many other respects the birds approximate to the reptiles, which furnish so many remarkable instances of torpidity. Professor Owen speaks of the respiratory function as finding its highest development in birds. He says, "Not only the ramifications of the pulmonary artery, but many of the capillaries of the systemic circulation, from the singular extension of air-cells through the body, are submitted to the influence of the atmosphere; and hence birds may be said to enjoy a double respiration. Though the heart of the bird resembles in some particulars that of the *reptilia*, the four cavities are as distinct as in the *mammalia*; but they are

relatively stronger, their valvular mechanism is more perfect, and the contractions of this organ are more forcible and frequent in birds, in accordance with their more extended respiration, and their more energetic muscular actions." We may remark upon this passage, that it would appear from the researches of Dr Davy,* that physiologists have not paid sufficient attention to the peculiar conditions of bird life, and have been ready to assume that the comparatively high temperature of birds was owing to a very great and active respiration, when most of it is really traceable to their feather clothing, and the inactivity of their skins, through which little transpiration occurs. Birds also drink little; and the loss of water from pulmonary exhalation is shown by Dr. Davy to be very small. The lungs of birds are small, though supplied with large veins, and their supplementary respiratory organs are inefficient as compared with a portion of highly developed lung. It seems therefore probable that they are not so remarkable for respiratory functions as Professor Owen states, or has been commonly supposed. If, for example, the bird experienced as much cutaneous and pulmonary exhalation as the mammal, could its respiration maintain even a mammalian temperature? From Dr. Davy's observations, the answer must be no.

The osseous system of birds, their muscular and nervous systems, their digestive, circulating, respiratory, and other systems, form the topics of separate chapters; and the volume concludes with descriptions of the osseous system in various kinds of mammals. In the chapter on the respiratory system of birds, facts are adduced which do not support the statement to which we have adverted—that the respiratory function reaches its highest development in this class. Thus the organs of respiration are described as having more of the reptilian than the mammalian type, and the air-cells and hollow bones seem more adapted to assist flight, and give mechanical help to respiration, than simply to conduce to the perfection of this process. Indeed, it would not be in conformity with scientific reasoning to regard a small lung, approaching the reptilian in type, and supplemented in this way, as evincing so high a development as the more complete lung of the mammal.

The second volume of Professor Owen's work is, like the first, richly illustrated, and the work, when complete, promises to be one of the most important that has been produced.

Reliquiæ Aquitanicæ: Being Contributions to the Archæology and Palæontology of Périgord, and the adjoining Provinces of Southern France. By Edward Lartet and Henry Christy. Part II. (Bailliere.)—The second part of this remarkably handsome and important work contains three quarto plates of stone implements, and one of carved horn, the ornamentation of which, though rude, shows a certain advance both in taste and execution. There are also several wood engravings, showing the methods adopted by existing tribes of mounting flint implements, resembling those of Pre-historic France. The authors wisely remark, that "implements of stone are to be regarded as indicating a grade of civiliza-

* Proceedings Roy. Soc., No. 78.

tion rather than any definite antiquity." And when we find the present natives of New Caledonia and Solomon Islands making tools as nearly as possible like those of the pre-historic Frenchmen, who were contemporaries of the mammoth, we are tempted to ask whether what we call instinct in animals does not manifest itself very strongly in the works of men.

THE ANTHROPOLOGICAL REVIEW, No. 13. (Trübner & Co.)—We should much like to see a number of the *Anthropological Review* that we could conscientiously speak well of, but until the Society has sown all its wild oats, and managed if it can to survive the process, this will be impossible. The publications of the Society in its present stage, lack all the qualities that give value to scientific discussion. They consist chiefly of reckless caricatures of the extreme theory of the influence of race held by Dr. Knox, and are, moreover, marked by a spirit that is neither dignified nor gentlemanly. The first paper in the present number is entitled "Race in Legislative and Political Economy," and it is devoted to an assault on the philosophy of John Stuart Mill, of which the writer has evidently a very slender and imperfect comprehension. If we understand its not very clear or precise language, it is intended to convey the notion that "there are savage races, adapted by structure and temperament, by habit of body and constitution of mind for the savage state," and not capable of advancing to a civilized state by any treatment, or under the influence of any circumstances. The writer objects to Mr. Mill's "thinking a savage tribe to be like an ignorant individual, in the want only of education, simply that and nothing more." If by education he means the prolonged influence of circumstances favourable to development and improvement, it may be a fair statement of Mr. Mill's opinions, but when he invites that philosopher to test traditions about the ancestors of Greeks, Romans French and English having been once in a savage state, by looking now to see if any really savage people of the Caucasian type exist, we suppose he means to assert that while other races originated as savages, and must necessarily remain savages as long as they endure, those of the Caucasian type were civilized at their commencement. The negro is, of course, abused by this writer, who calls him a "barbarian in his habits," and "a savage in his hereditary proclivities." Does this gentleman trace his own faults to such inevitable hereditary proclivities? If so, had not the Review better dispense with his services?

In the *Popular Magazine of Anthropology*, printed with the *Anthropological Review*, as well as separately, we are asked whether we know what the great southern continent of Australia means? The inquirer proceeds, "Are the telluric influences alike on both sides of the equator? Is not the northern hemisphere preponderantly positive, and the southern as predominantly negative? And, as a result of this, do not animate types in the former tend to cerebral and thoracic development, while in the latter they tend as persistently to the lumbar and abdominal? And is not this equivalent to saying that the first are essentially masculine, and the second feminine in their organic proclivities and profounder character-

istics?" If the concocter of this passage should ever be so fortunate, or unfortunate, as to know what he meant when he wrote it, we presume he will make his discovery public in some future paper. The same writer informs us that when we get an Indian into broadcloth, or an Australian into uniform, we have "only a talking parrot, a well-bred wolf, a performing tiger, whose congeners still in the forest are what they ever were; and who without that forest, their native habitat, to live and build in, would ultimately perish like beasts in a menagerie."

To show that we cannot do less than protest against the want of decency—caused, we suppose by inerradicable racial proclivities—in which the *Anthropological Review* indulges, we may mention that Dr. Livingston is described as having "a poor naked mind, bedaubed with the chalk and red ochre of Scotch analogy, and with a threadbare tattered waistcloth of education hanging about him." We trust that the members of the society by which this publication is issued, will see the propriety of putting a decisive stop to such a flagrant breach of good manners as the unfortunate author of this passage has here committed, and would no doubt commit again if opportunity be permitted.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.—*March* 21.

A COMMUNICATION was read on the FOSSIL BRITISH OXEN.—Part I., *Bos Urus*, Cæsar. By W. Boyd Dawkins, Esq., M.A., F.G.S.—The problem of the origin of our domestic races of cattle was considered by the author to be capable of solution only after a careful examination of each of the three European fossil species of oxen, namely, *Bos Urus* of Cæsar, *B. longifrons* of Owen, and *B. bison* of Pliny. In this paper he began the inquiry with *Bos Urus*, Cæsar, being the *Bos primigenius* of Bojanus, and he arrived at the conclusion that between this species and *Bos Taurus*, or the common ox, there is no difference of specific value, though the difference in size and some other characters of minor value render the bones of the two varieties capable of recognition. After giving the synonymy of *Bos Urus* in some detail, and measurements of the different bones as represented by specimens from a number of localities, Mr. Boyd Dawkins described the range of the species in space and time, showing that it coexisted in Britain with the Mammoth, *Rhinoceros leptorhinus*, *R. megarhinus*, and *R. ticorhinus*, and was associated with *Elephas antiquus*, *Felis spelæa*, *Ursus spelæus*, *U. arctos*, *Bos priscus*, *Megaceros Hibernicus*, *Cervus elaphus*, *C. tarandus*, *Equus fossilis*, etc., and held its ground during the Pre-historic period, after most of these animals had become extinct or retreated from this country. The precise date of its extinction in Britain was stated to be somewhat uncertain, although the author

inclined to the belief that it existed in the wild state as late as the middle of the twelfth century, while on the continent it seems probable that it lingered until the sixteenth century. The author then endeavoured to explain its gradual diminution in size by the progressive encroachment of cultivation on its old haunts; and, in conclusion, stated his belief that at least the larger cattle of Western Europe are the descendants of the *Bos Urus*, modified in many respects by restricted range, but still more by the domination of man.

Further Documents relating to the Formation of a New Island in the Neighbourhood of the Kaimeni Islands. By Commander G. Tryon. Communicated by the Lords Commissioners of the Admiralty.—A detailed account was here given of the formation of the new Island, named "Aphroessa" by the Greek Commissioners. It was stated to be one hundred yards long by fifty wide, and to be daily increasing in size. Volcanic eruptions had taken place in two localities, one in the new island, and the other in what was called Mineral Creek, which is about two-fifths of a mile distant, and which had been completely filled up with lava. Considerable concussions were experienced at Patras, and other parts of Greece, which were by some attributed to an earthquake, and by others to volcanic explosions; but, with these exceptions, no earthquake had attended the eruptions or the formation of the island.

April 11.

A paper was read on the Occurrence and Geological Position of Oil-bearing Deposits in New South Wales," by the Rev. W. B. Clarke, M.A., F.G.S.—The author first described the oil-producing schists and cannels of New South Wales as they exist at Colley Creek, at the head of the Cordeaux River (Illawarra shales), at various places in the Wollondilly and Nattai valleys, at Reedy Creek (Hartley Cannel), Stoney Creek, and elsewhere; as well as a substance resembling "Bog-butter," occurring at Bournda, and probably of very recent date. Respecting the Colley Creek Cannel described in the previous paper, Mr. Clarke observed that he saw no porphyry near it, but that a seam or mass of the Cannel, which here contains numerous scarcely rounded grains of quartz, was passed through in the midst of a series of layers of black, partly unctuous clay, which also contained many similar quartz-grains; these grains gave to the clay a porphyritic aspect, so that by sight alone one might be led to consider them a decomposed porphyry. The chief conclusions at which the author arrived were (1), that, with the exception of the Stoney Creek Cannel, all the oil-producing deposits occur in the Upper Coal-measures, and that the Cannel of Stoney Creek, on the River Hunter, occurs in the Lower Coal-measures, which are above the Lower Marine beds with Trilobites, below which again are numerous fossiliferous beds before the porphyry is reached; and (2) that the Cannel belongs to beds in which *Glossopteris* occurs, and therefore may be a slight additional evidence of their antiquity, as it is an analogue of the "Bog Head" Cannel of Scotland.

AERONAUTICAL SOCIETY.—*April* 17.

Aeronautical Society of Great Britain.—At a meeting of Council, held at Stafford House on the 17th inst., James Glaisher, Esq., F.R.S., in the chair, several donations and new members were announced. Mr. F. W. Brearey, Honorary Secretary, read a paper contributed by Dr. Fairbairn, advocating perseverance in meteorological researches, "with a view of increasing our knowledge of the law of storms, and of electric and magnetic phenomena, which enter so largely into the movements of elastic fluids when united to vapour and heat in the shape of clouds."

Mr. Butler contributed some interesting facts as to the progress of the science in France, gathered in his visit to Paris since the last meeting. Some discussion ensued as to the feasibility of an exhibition for a short time in London of the various models which illustrate the mode of ascent into the atmosphere without the aid of balloons, and Mr. Butler undertook to communicate the views of the Council to the French Societies, so that the inventions of both countries might be collected in one exhibition.

It was arranged that the first experiments under the auspices of the Society should take place next month, conducted by Mr. Glaisher and Westcar, of the Royal Horse Guards, when, in addition to observations of a meteorological nature, some experiments specially adapted to the confirmation of a theory as to the flight of birds by Mr. Wenham, C.E., should be attempted from the car of a balloon.

A general meeting of members was advocated at as early a date as should be warranted by the value of the information to be imparted to them.

ZOOLOGICAL SOCIETY.—*April* 10.

The Secretary called the attention of the Meeting to some recent additions to the Society's Menagerie, amongst which were particularly mentioned two species of Australian birds (*Psephotus pulcherrimus* and *Otis australis*) never before exhibited in the Society's Gardens.

Mr. J. Gould exhibited specimens of the trachea of an Insessorial bird, from Cape York, North Australia (*Manucodia Gouldi*, G. R. Gray), which was of very remarkable form and structure.

Mr. Tegetmeier exhibited and made some remarks upon a supposed original drawing of the Dodo (*Didus ineptus*), in which the colour of that extinct bird was represented as being nearly white.

Dr. Gray gave a notice of an Ape (*Macacus inornatus*) and a Bush-buck (*Cephalophus breviceps*), in the Gardens of the Society, which he considered to belong to undescribed species.

MICROSCOPICAL SOCIETY.—*April* 4.

On April 4, the Annual Soirée of this Society held at King's College, attracted a numerous concourse of visitors, including many distinguished persons. The display of microscopes was very good, and some important novelties might be observed. Mr. Ross exhibited some fine instruments, with a good selection of striking objects; Messrs. Smith and Beck did the same, and exhibited for Mr. Wenham a new binocular arrangement, devised by that gentlemen for use with high powers. We have given a description of this invention in another place, accompanied by a diagram showing the peculiar compound prism which Mr. Wenham has devised. Messrs Powell and Lealand exhibited their new binocular arrangement described in our April number. Mr. Highley brought a fine collection of his educational slides for the magic lantern, which open out a valuable mode of illustration for lectures on physiological and natural history subjects. He likewise showed a new and exceedingly compact pocket microscope, well adapted for tourists and seekers after small objects, such as the desmids and diatoms. When folded up, it goes into the space of a small pocket telescope, and when opened is well supported on a tripod stand. Mr. Cooke exhibited a clever apparatus for making drawings of microscopic objects. He adapts the ordinary microscopic objectives and apparatus to a camera arrangement, by which a clear magnified image of the object to be delineated is thrown upon a table, made into a dark chamber by a curtain, through an opening in which the hand is inserted and the image seen. For night use Mr. Cooke employs a good lamp with a reflector, and for day use he has devised an economical heliostat, by means of which solar light can be employed. Messrs. Pillischer, Baker, Horne and Thornthwaite, Murray and Heath, Crouch, Collins, and other known makers, made an effective display of instruments, and Mr. Wheeler brought an imposing collection of microscopic objects.

PROGRESS OF INVENTION.

In places where railways are most needed, but owing to disadvantages of the ground and other hindrances, the transport and use of large instruments proper for pioneering them is often most difficult, an instrument at once portable, and capable of replacing a theodolite in setting out railway curves, becomes a *desideratum*. An instrument called a "CYCLOSCOPE," or curve-tracing instrument, invented and patented by Mr. H. Temple Humphreys, Associate of the Institute of Civil Engineers, is calculated to meet this want, by measuring angles, and setting out railway curves with increased facility. It may be shortly described as an instrument combining the advantages of a pocket-sextant with the principles of a kaleidoscope. When the two plane mirrors of an ordinary pocket-sextant are turned towards a distant object, so that by one combined reflec-

tion between both mirrors, a reflected image of the object is obtained, the angular interval between the image and the object is twice the angle contained between the mirrors. Repeated reflections of the same kind would, of course, produce a series of images, growing dimmer, arranged at the same angle from each other as the first image from the object. This is found to be the case when the object is indefinitely distant. When the object is near, as in the common kaleidoscope, and placed between the mirrors, it is seen repeatedly reflected in the mirrors at equal intervals along the circumference of a mathematically true circle, the centre of which is the intersection of the mirrors. In all positions whatever, of an object viewed by reflection with two plane mirrors, this actually remains true. The object appears the first of a series of images arranged at equal intervals round the circumference of a circle; the centre of which is the point of intersection of the mirrors with each other, or of the images, if need be, produced. Of the two plane mirrors with which the cycloscope is entirely composed, the front mirror is half silvered, and it is brought into any convenient inclination with the entire mirror behind it, by turning a screw. The parts of a revolution of the screw correspond to minutes of a degree of inclination. When the last chained peg of the straight line, immediately preceding a railway curve, is seen directly through an eye-hole in the centre of the entire mirror, its successive combined reflections at the same time meet the eye at equal tangential angles, and trace out a circle the direction of the intended curve. The curve can then be set out by pegs, placed at equal chained distances apart, in the direction of the combined reflections. By this means several points of a railway curve can be set out at one sight, and the necessity of repeated removal and readjustment of a theodolite in the ordinary mode of setting out railway curves is avoided. The instrument, which is made by Mr. Stanley, at the Great Turnstile, London, resembles a pocket-sextant in being also a small and portable construction for measuring distances and angles of moderate width.

Economic Preparations of Citric Acid.—Hitherto it has been found inconvenient to prepare this acid where the lemons are grown—that is, where they are to be obtained cheaply, and in abundance—on account of the complication of the process employed. This difficulty has, however, been removed by M. Perret, who forms, by very simple means, a salt which may be stored up for an indefinite period, without risk of injury. After the lemon-juice has been freed mechanically from its impurities, it is treated with excess of magnesia, which causes tri-metallic citrate of magnesia to precipitate, as a brilliant granular powder, of considerable density, that separates easily from water, and, as appears by examination with the microscope, consists of minute prismatic crystals. Neither change of temperature nor moisture injure this compound. The use of a process, which is inexpensive, and applicable in all circumstances, must lead to the more abundant production of citric acid: and, by consequence, to a fall in its price—a matter of considerable importance, on account of the very valuable properties of the acid.

COLOURIZATION OF PHOTOGRAPHS BY MEANS OF POLARIZED LIGHT.—When polarized light is transmitted through plates of mica, of suitable thickness, the most brilliant and beautiful colours are produced. This fact has been for some time past applied to the colourization of natural objects, such as birds, butterflies, etc., and it has now been adapted to photography. For this purpose, plates of mica, of the thicknesses which are required to produce the proper tints, are cut so as to correspond with the outlines of the subject, and are fastened to the back of the photograph by means of isinglass glue, their position being determined by that of the plane of polarization. Only flat tints are thus obtained from the plates; but these, as is long known, are suited to the production of the most beautiful effects with engravings, and they answer still better for photographs. The polarized light may be obtained by means of a glass plate coated with black varnish. If the photograph makes with this plate an angle complementary to 35° 25′, parallel rays of polarized light will be transmitted through it, and may be analyzed by a few glass plates placed within a hollow prism or cylinder, and making, with its axis, an angle of 35° 25′, the end of the cylinder next the eye being closed with a cap, having a very small aperture. If a convex lens of low magnifying power is attached to this aperture, so much the better. The instrument is in proper order when, on turning it round, while directed to the photograph, there are two positions in which the field is perceptibly darkened. While the analyzer is being rotated, the tints vary, at first in intensity, and then are replaced by complementary colours, which often cause the picture to produce the effects of a caricature.

NEW APPLICATION OF THEINE.—It has recently been discovered, by a German chemist, that a most beautiful scarlet or purple dye-stuff may be produced by means of theine. Were tea the only source whence this alkaloid could be obtained, such a discovery would be of little value; in reality, however, the supply of theine is practically unlimited. The leaves of the *Paulina sorbilis*, and those of the *Ilex paraguensis*—the former a species of horse-chestnut, and the latter a species of holly, contains five per cent. of it, which is quite as much as is afforded by the very best kinds of tea. Both these grow abundantly in Brazil, and millions of tons of their leaves, which fall annually, and are applied to no purpose, might easily be utilized.

IMPROVED MODE OF SEPARATING SILVER FROM LEAD.—Hitherto the separation of silver from lead was a troublesome process, and did not afford a profitable return, when the quantity of silver was small. It has been found, however, that almost the whole of the lead may be removed by very simple and inexpensive means. After the metal has been brought to a state of fusion, it is run into a pan, and having been covered with small pieces of coke, a small jet of water is thrown upon it. The whole is then kept well agitated, which causes a uniform cooling; and when this has proceeded to a certain extent, the solid mass of coke and lead is removed. The residual fluid is extremely rich in silver, which may be separated in the usual way, at a comparatively small cost.

APPLICATION OF TURNIPS TO THE PROCESS OF DYEING.—The process

of dyeing with indigo, though extremely simple in theory, is attended with difficulties in practice that demand the skill of an adroit and experienced workman. M. Leuchs, of Nüremberg, has so simplified the operation, that it may now be performed by any one with ease and certainty. He avails himself of the property possessed by *pectine* of changing insoluble blue into soluble white indigo. Fortunately, pectine is very plentiful, being found in large quantities in pumpkins, melons, etc., but most abundantly of all in turnips. Nor is it required, for the purpose of dyeing, to separate it from the turnips; it is only necessary to cut them up in small pieces, after which they are ready for use. Their efficiency, in this state, may be shown by a very simple and striking experiment. A small quantity of indigo, and a few drops of a solution of a caustic alkali, and then a little bit of turnip, are to be placed in a tube closed at one end; after which, heat is to be applied. The indigo becomes, in a very short time, colourless and soluble. On the large scale, one hundred parts, by weight, caustic ley, at a temperature of 75° Cent., one part indigo, and five parts turnips chopped very small, are used—the turnips being put within a wire cage, which is suspended in the liquor. When all the ingredients have been added, the temperature is raised to the boiling point: and as soon as the indigo has become colourless, the solution is decanted off, and requires no further preparation for use in dyeing. About five per cent. of the turnips are left as a residue, which answers well in paper-making. At places where, or during seasons when turnips cannot be had, an essence extracted from them with water, under a pressure of two or three atmospheres, answers equally well—about four parts by weight of it being used for one part indigo. The employment either of the turnips or their extract, prevents that waste of indigo which is almost inseparable from the ordinary process.

Gelatinous Phosphate of Lime.—The property which phosphate of lime has been found to possess, of accelerating putrefaction, is very remarkable; and tends greatly to explain its efficiency, both as a manure, and as a curative agent in certain forms of disease. Its putrefactive qualities have been established by very simple but satisfactory experiments. Fish glue was dissolved in distilled water, and the solution was divided into two portions. To one of these gelatinous phosphate of lime was added, and both, after having become a jelly by cooling—the one being opaque, and the other transparent—were exposed to the very same temperature. The portion to which the phosphate was added became, in thirty-six hours, a liquid, and exhaled a most offensive odour: the other remained without any change for six days, and at the end of that time merely emitted a musty smell. Also some chopped beef was divided into two portions, to one of which gelatinous phosphate was added. In thirty hours the portion to which the phosphate was added became putrid; the other not until the seventh day. The energetic action of the phosphate, in these cases, has been explained by the fact that, as M. Pasteur has shown, it is necessary for the development of the sporules, which, by producing minute organiza-

tions, cause putrefaction, and which are present everywhere in the air, ready to attach themselves to anything suited to receive them. Such being its mode of operation, it must necessarily improve manure, by decomposing its organic matters; and its presence in fish, and other articles of food, may materially aid digestion. So far from being a mischievous, it would be a useful addition to aliment, as it supplies matter for bone.

Transformation of Motion into Heat.—Numerous instances of this transformation occur daily; that it certainly takes place, even in the case of fluids, has been demonstrated in the most satisfactory manner by M. Rennie. He boiled an egg, by merely placing it in a vessel which contained about ten pounds of water, and which was made to revolve 232 times in a minute. It is clear that, in this case, motion was the only possible source of heat; and the result was the more striking, as the friction of fluids is so very much less than that of solids.

A New Optical Instrument.—A very curious instrument has recently been invented by M. Houdin. He calls it the *Iridoscope*, from the facility which it affords of observing the motion of the iris. It seems to have been suggested by the effects perceived on looking at the light transmitted through a decanter of water. Should the latter contain no foreign substances floating through it, the light forms a brilliant disc; but should opaque bodies be present, they are rendered perceptible. To apply this fact, he places on the eye an opaque shell, which is sufficient to cover it, and which has in the centre a very small aperture, through which the sky or some other diffused light is to be viewed. In ordinary circumstances, merely a disc of light will be seen; but in abnormal states of the eye the case will be different. Hence this instrument enables any one to become cognizant of all that takes place in his own eye—the flowing of tears, the aqueous humour poured in when the eye is fatigued, the veil which shades the light when cataract is being formed, the dilatation and contraction of the iris, etc.; and the experiment may be tried very satisfactorily with a pill-box, in which a hole has been made with a very fine needle.

New Galvanic Battery.—A modification of the Bunsen battery has been devised by M. Gerardin, which seems both economic and highly effective. The zinc element is replaced by iron turnings, which are immersed in common water, a plate of iron being thrust into them, for the purpose of forming the positive pole. The porous cell contains a solution of perchloride of iron, to which nitro-hydrochloric acid has been added. The negative pole is formed with gas retort graphite, which has been pulverized, and then agglomerated with paraffin. A very large amount of galvanic power may be obtained with a battery of this kind, at a small cost.

New Solvents for Gold.—M. F. Nicklès has usefully developed the fact, that gold is soluble whenever chlorine or bromine are given off. As to iodine, it unites only indirectly with that metal. He has found that gold is soluble in ethereal solutions of the perchlorides and perbromides; also in solutions of the sesquichlorides and sesquibromides, which—such as those corresponding to the ses-

quioxides of manganese, nickel, and cobalt—are easily reduced. The stable sesquichlorides—that of iron for example—have no action on gold. Although iodine has but little affinity for gold, a periodide tube dissolves it rapidly. This may be illustrated by projecting into hydriodic acid a peroxide, a metallic acid, or any oxide, the corresponding iodide of which is less stable than protiodide; and then adding leaf gold. A protiodide is formed, and iodine in the nascent state is let free. The presence of ether assists the solvent power: it is more effective than water in determining the decomposition of hydriodic acid, and dissolves iodine and iodide of gold with facility. Hence, if gaseous hydriodic acid is transmitted into ether containing leaf gold, some of the latter will be dissolved, hydriodic acid being decomposed. Aqueous hydriodic acid has no effect on gold.

MISCELLANEOUS.—*The Colour of Red Wine.*—The adulteration of wines being so general, a mode of detecting any of the sophistications employed is a matter of some importance. In no way is even tolerably good wine more tampered with than in regard to its colour. It has been ascertained, however, that its artificial colouration may be very easily detected. For this purpose, a small piece of bread, or of sponge which has been well washed, is to be dipped into the suspected wine, and then placed in water. If the dark colour of the wine has been produced unfairly, the water will be, at once, tinted a red violet; otherwise not until after about half an hour.——*New Application of Chloroform.*—Both flour or meal, and the mineral substances ordinarily used to adulterate them, are completely insoluble in chloroform. This fact has suggested a very satisfactory mechanical test of the purity of farinaceous matters. A portion of the meal or flour that is to be examined having been placed in a tube which is closed at one end, the tube is to be nearly filled up with chloroform, and the open end, having been well closed with a cork, is to be agitated for a short time. All the farinaceous matter will be found collected on the surface of the chloroform: and the mineral matters, if any is present, will have subsided to the bottom. Should there have been an adulteration with mineral matter, it will thus be rendered distinctly perceptible.——*Allotropic States of Oxygen.*—The researches of M. Schönbein have led him to conclude that oxygen may exist in three allotropic states. Ozone and antozone constitute two of these, and ordinary oxygen, a combination of the others, the remaining one. Normal oxygen may be decomposed into its elements; but as yet he has not been able to obtain either of these unmixed with it.——*New Industrial Application of Hydrofluoric Acid.*—In the manufacture of beet-root sugar, half the crystallizable sugar has been hitherto left behind in the juice, on account of the difficulty of finding an acid capable of removing the alkali contained in the juice, or introduced into it, during the processes employed, without injuring the organic matters. It has been discovered, however, that hydrofluoric acid not only possesses all the qualities so long sought for, but, in addition, renders the clay which is employed in the manufacture more energetic in its action. Four per cent., and afterwards eight per cent. hydrofluoric acid, expanded by a tempera-

ture of 40° Cent., and afterwards removed at a temperature of 70° Cent., with a suitable quantity of lime, affords a juice which contains about eighty-eight per cent. of crystallizable sugar. Ordinary juice contains only about eighty per cent., which is obtained also at a greater cost.

NOTES AND MEMORANDA.

ERUPTIONS AT SANTORIN.—The *Archives des Sciences* supplies an historical notice of Santorin eruptions. The ancients called Santorin Thera and also Kalliste, or the Beautiful. Pliny states that it rose out of the waters. The islands of Therasia and d'Aspronisi make with Santorin the shape of a truncated cone, of which the crater or centre is occupied by the sea, forming a space nearly three leagues long and nearly two wide. In 225 B.C. a violent earthquake separated Therasia from Santorin. In the sea space just spoken of are three islands, named Kaïmeni. The most ancient of these, Palea Kaïmeni, appeared above the water with flames that lasted four days in the year 186 B.C. In 19 A.D. the island Thia made its appearance, and another island came up in 60 A.D. Both these islands are now united to Palea Kaïmene at Hiera. In 726 A.D. flames, stones, and smoke were ejected, and rocks emerging from the sea joined Hiera. In 1457 and 1508 it received fresh additions. Mikra Kaïmene rose up in 1573, with a crater forty or fifty feet high. In 1650 fresh earthquakes occurred, and anisl and to the north of Santorin was formed, and subsequently destroyed. In 1711 a shoal appeared without a shock or eruption, but earthquakes soon followed. Movements of elevation continued, but no further eruption occurred till that of the 28th and 29th of January, 1866, when flames burst forth accompanied by violent noises. On the 31st of January, the promontory of Volcano was split off from Nea Kaïmene. The little island thus formed sank sixty centimetres in two hours, and after sank at the rate of ten centimetres an hour, and the inhabitants took to flight. On Feb. 1, the sinking was at the rate of five centimetres an hour. During this time, flames continued between the two Kaïmene. On the following day, Feb. 2, a shoal came within a fathom of the surface, between Nea and Palea Kaïmene, where English charts showed forty-five fathoms of previous depth. From Nea Kaïmene this shoal or island was seen hour by hour to rise slowly and silently, without smoke. By the evening it was fifty metres long, ten or twelve broad, and twenty or thirty above the sea. On the 3rd and 4th it grew still bigger. M. Lenormont thinks that this isle occupies the place of the Isle of This, formed in 19 A.D. On the 9th of February the island was still growing, its dimensions then being 140 metres in length, sixty-five broad, and forty-five in height; and at night it looked like a mass of coal in combustion. On the 9th March, we see from *Comptes Rendus* that M. Fouqué found the island fifty metres high. The island Aphroessa formed on the 13th of February, he found to be about 100 metres in circumference, and fifteen to twenty metres above the sea. The new formations are of a black, vitreous, very felspathic lava. On 10th inst. a new island was seen near Aphroessa which did not exist the evening before. It was thirty to forty metres in diameter, and a meter and a half above the sea.

THE FLOAT OF THE IANTHINA.—That interesting little shell-fish the Ianthina is well known to attach to its foot, near the posterior end of that organ, a long float, composed of vesicles of mucous inflated with air. The *Annals Natural History* has a paper translated from Lacaze-Duthiers on the manner in which this curious apparatus is formed. He finds that the creature curls up the anterior extremity of its foot, thrusts it out of the water, and imprisons an air bubble. It then applies the fore part of the foot to the back part, secretes mucous, and fixes a mucous bubble. To this other bubbles are attached, until the float reaches the dimensions necessary to float the shell. M. Lacaze-Duthiers says that everything indicates that the shell and the animal are of a weight which does not allow them to swim without a float, and those which remain at the bottom of the water quickly die. The air for the bubbles is not secreted by the animal, but obtained

by thrusting its foot above the water. When the float is so damaged that the creature cannot reach the surface, it is unable to make fresh bubbles, and perishes.

BIELA'S COMET.—In *Astron. Nachr.* Herr F. von Franzenau gives the position of this object for May. May 5, 10, and 15, R.A., 11h. 32m. 3s., 11h. 40m. 10s., 11h. 47m. 39s.; D., 15° 26—14° 24—13° 44'.

SPECTRA OF α ORIONIS AND SIRIUS.—Padre Secchi has published an account of these spectra, as seen in the Roman Observatory, which throws considerable doubt on his instrumental means or special acquaintance with this class of objects. That which gave value to Mr. Huggins' observations was the great care taken by Dr. Miller and himself to make accurate measurements of the more important lines, to compare their position with those in the spectra of various elementary substances. Sixteen of these comparisons were made in the case of the spectrum of α Orionis. P. Secchi finds the spectrum of α Orionis to exhibit bands "almost as the spectrum of nitrogen," and that of Sirius to resemble sulphur. The observations of Mr. Huggins and Dr. Miller do not confirm these views. During the last two years they find no change in the *position* of any of the lines, but they say (see *Monthly Notices*), "α Orionis is a variable star of great irregularity, both of period and of extent of change of brightness. Now we have recently found that the group of lines and shading as if of fine lines terminated at its more refrangible end by the strong line. No. 1069·5 in our diagram is not at present visible in the spectrum of this star. The absence of this group is of great interest in connection with the variability of the star's light, especially as the time of the disappearance of the group coincides with the epoch of the maximum brilliancy of the star." They do not see anything to suggest the resemblance to spectra of sulphur and nitrogen which P. Secchi supposes.

THE COMPANION OF ANTARES.—Mr. D. A. Freeman writes in the *Monthly Notices*, that turning his 4½ inch Cooke refractor, at Mentone, an hour before sunrise, towards Antares he saw the companion clearly visible, and of a green colour. Being seen with so small an aperture, he wonders that it has only been recently discovered, but he states that the atmosphere was in an unexceptionably fine condition.

MORRIS'S ROTATING OBJECT-HOLDER.—Though not possessing the mechanical movements which make Mr. Richard Beck's revolving disc-holder so convenient for delicate investigation, Mr. Morris's invention, made by Messrs. H. and W. Crouch, will be a useful addition to microscopic apparatus. It consists of a brass plate, about the size of an ordinary slide, and in the centre is a disc-carrier, mounted on a ball and socket universal joint. The disc-holder can be removed, and a smaller one substituted, or a slide-holder inserted in its place. The principal use, we think, Mr. Morris's holder will be put to is to carry opaque uncovered objects intended to be viewed with low powers. Such things as minerals, elytra of beetles, etc., could be conveniently gummed on to discs of blackened cork, any one of which could be inserted or easily removed from the holder, and tilted at any angle required. We believe the priority of invention of a disc-holder with motion in various directions belongs to Mr. Beck, and his apparatus is the most complete. There is, however, room for Mr. Morris's plan, as well as for Mr. Beck's, and we have no doubt it will be liked by many microscopists.

CHEMICAL ACTION OF THE PANCREATIC JUICE.—The study of the function performed by the pancreatic secretion in the animal economy, has led to the discovery of properties possessed by it, which, in a chemical point of view, are of great interest. In ordinary circumstances, fat is incapable of mixing with water. After having been heated along with that fluid, it will separate perfectly from it, even before cooling. Such is not the case if it has been previously heated with fresh and acid pancreatic juice. It will then form an emulsion by mere mixture with water, a circumstance which is remarkable, as its constitution has undergone no change that our present chemical knowledge will enable us to detect. That a change has taken place in it is, however, certain; and it is equally certain that this change is not saponificatious, as the fat globules remain perfectly distinct, and of nearly uniform size. The researches of chemists will, no doubt, ultimately throw light on the circumstance, which may lead to important results in more departments than one of practical science.

On the Times of Appearance of some Lepidoptera in 1865.—We have received the following from Mr. J. R. Clifford:—"The 'season' of 1865, considered entomologically, was a rather singular one. Though scarcely to be called a specially 'good' year, yet several insects usually uncommon turned up in great abundance; and there are many authentic records of captures of species excessively rare. But, as a set-off against this, other species, ordinarily taken in some plenty, were difficult to pick up; so that, on the whole, the year would not be on the par with some prolific ones, such as 1851.

"We now wish to note down some of the dates of appearance of certain Lepidoptera, most of them common, which came within our own observation. It may be premised that the season was what would be considered a forward one, the great majority of species appearing earlier than their wont; though there are some species so resolutely periodic, that they refuse to fluctuate, be the weather what it may.

"These observations that follow have reference only to the vicinity of London; and such appearances as were possibly the casual emergence of a stray specimen some time before the bulk of his brethren, are not recorded. In each case the date given is the earliest *bonâ fide* appearance.

Hybernia progemmaria	March 24.
Biston hirtaria	April 7.
Tæniocampa instabilis	April 9.
Hybernia leucophearia	April 13.
Selenia illunaria	April 16.
Eupethecia vulgata	May 1.
Anthocharis Cardamines	May 3.

(In connection with this species, I name a curious circumstance, showing how greatly the distance of a few miles even will sometimes affect the appearance of a species. By the 20th of May, at Acton, in Middlesex, the species had nearly disappeared, while near Shirley, in Surrey, on the 26th, examples of it were to be seen in a very fresh state.)

Rumia cratægata	May 4.
Hemerophila abruptaria	May 4.
Cidaria immanata	May 4.
Dicranura vinula	May 6.
Platypteryx unguicula	May 7.
Orgyia pudibunda	May 19.
Smerinthus Tiliæ	May 20.
Argynnis Euphrosyne	May 20 to 24.

(Very plentiful to the south of London; but had evidently been out some days previously, the wings having lost their pristine beauty.)

Ephyra pendularia	May 20.
Hepialus Lupulinus	May 24.
Chortobuis pamphilus	May 24.
Plusia Gamma	May 26.
Smerinthus Populi	May 27.
Cabera exanthemaria	May 27.
Pygæra Bucephala	May 29.
Anarta Myrtelli	May 30.
Papilio Machaon	May 31. (Bred.)
Euplexia lucipara	June 1.
Sesia tiputiformis	June 4,
Aspilates stregillaria	June 6.
Sphinx Ligustri	June 7.
Dicranura bifida	June 8.
Sesia apiformis	June 9.
Ligdia adustata	June 9.
Orgyie gonostegma	June 18.
Euthemonia russula	June 20.
Pyralis fimbrialis	June 21
Acronycta megacephala	June 26.
Pseudoterpra cytisaria	June 28.
Bombyx neustria	July 7. *Cetera desunt.*"

Crystallization at Various Temperatures.—Mr. Thomas communicates to the Oxford Microscopical Society an account of a series of experiments in crystallizing for the microscope the double salt, sulphate of magnesia, and sulphate of zinc, made with a Bunsen burner, and a stand on which he could arrange slides at various distances. At 75° he obtained a pattern with a cross, the arms of which were curiously curved. He says, "It seems also that the two salts combine at this temperature in two proportions to form two distinct crystals, one having a distinct axis with a considerable amount of double refraction; the other being in the form of rounded masses with small exfoliations and a less amount of double refraction." At 85°, 90°, and 100° he finds the wave patterns become smaller, and resemble fine wires flowing into each other. At 117° the rings become obliterated, the crystal arranges itself in planes radiating from the centre. At this temperature about three hours are required for the development of the crystals. Sulphate of copper and sulphate of magnesia give still finer results.

Agamic Reproduction in an Acarus.—The April number of the *Quarterly Journal of Microscopical Science* contains a paper on this subject by Mr. Richard Beck. He found that, after keeping one or two species of Acari for a considerable time, they disappeared. Further search revealed another kind of acarus, which proved to be a predaceous sort, devouring other acari, and even its own species. It had remarkably large falces, and laid eggs which were rather small in proportion to the size of the parent. The young, as it comes from the egg, has only six legs. It is white, perfectly transparent, and very active. At the age of seven days it casts a skin, and then acquires eight legs. Mr. Beck could not detect a male among his hatched specimens. He isolated one which laid eggs, and he again isolated another hatched from one of these eggs, and isolated two more, one of which was killed and the other laid eggs. This evidence is very strong in favour of agamic reproduction.

Daubrée on Meteorites.—Recent researches of M. Daubrée tend to show that meteorites do not differ from terrestrial combinations of matter to the extent formerly supposed. He finds peridot, lherzolite, and serpentine, three terrestrial minerals, to bear considerable resemblance to them, and he has succeeded, to a certain extent, in imitating them by artificial combinations. He says that the principal difference between meteoric and terrestrial rocks depends on the greater oxydation of the latter, and that if metallic iron, commonly present in the former, is absent in the latter, the difference is due to the quantity of oxygen which the atmosphere of our globe contains. He calls peridot "a sort of universal scoria," found alike in our deeper rocks, and in meteoric stones.

WHITE-HEADED WOODPECKER.

Picus albolarvatus. (Baird.)